

MOSFET - Power, Single N-Channel, D2PAK 650 V, 190 mΩ, 20 A

NVB190N65S3F

Description

SUPERFET® III MOSFET is ON Semiconductor'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® MOSFET's optimized reverse recovery performance of body diode can remove additional component and improve system reliability.

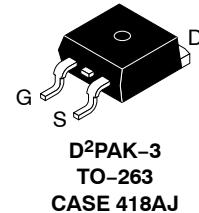
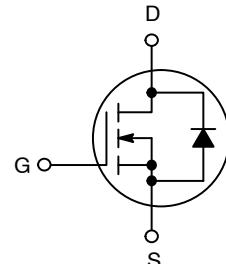
Features

- 700 V @ $T_J = 150^\circ\text{C}$
- Typ. $R_{DS(\text{on})} = 158 \text{ m}\Omega$
- Ultra Low Gate Charge (Typ. $Q_g = 34 \text{ nC}$)
- Low Effective Output Capacitance (Typ. $C_{oss(\text{eff.})} = 314 \text{ pF}$)
- 100% Avalanche Tested
- Qualified with AEC-Q101
- These Devices are Pb-Free and are RoHS Compliant

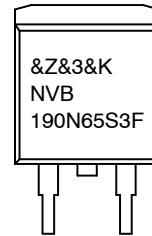
Typical Applications

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

| $V_{(\text{BR})\text{DSS}}$ | $R_{DS(\text{ON})} \text{ MAX}$ | $I_D \text{ MAX}$ |
|-----------------------------|---------------------------------|-------------------|
| 650 V | 190 mΩ @ 10 V | 20 A |



MARKING DIAGRAM



&Z = Assembly Plant Code
&3 = Data Code (Year & Week)
&K = Lot
NVB190N65S3F = Specific Device Code

ORDERING INFORMATION

See detailed ordering and shipping information on page 7 of this data sheet.

NVB190N65S3F

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 | ± 30 | V |
| | | – AC ($f > 1 \text{ Hz}$) | ± 30 | |
| I_D | Drain Current | – Continuous ($T_C = 25^\circ\text{C}$) | 20 | A |
| | | – Continuous ($T_C = 100^\circ\text{C}$) | 12.7 | |
| I_{DM} | Drain Current | – Pulsed (Note 1) | 50 | A |
| E_{AS} | Single Pulse Avalanche Energy (Note 2) | | 220 | mJ |
| I_{AS} | Avalanche Current | | 2.8 | A |
| E_{AR} | Repeated Avalanche Energy (Note 1) | | 1.62 | mJ |
| dv/dt | MOSFET dv/dt | | 100 | V/ns |
| | Peak Diode Recovery dv/dt (Note 3) | | 50 | |
| P_D | Power Dissipation | $T_C = 25^\circ\text{C}$ | 162 | W |
| | | – Derate Above 25°C | 1.3 | $\text{W}/^\circ\text{C}$ |
| T_J, T_{stg} | Operating Junction and Storage Temperature | | –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. $I_{AS} = 2.8 \text{ A}$, $R_G = 25 \Omega$, starting $T_J = 25^\circ\text{C}$.
3. $ISD \leq 10 \text{ A}$, $di/dt \leq 200 \text{ A}/\text{s}$, $V_{DD} \leq 400 \text{ V}$, 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. | 0.77 | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient, Max. | 40 | |

NVB190N65S3F

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

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

OFF CHARACTERISTICS

| | | | | | | |
|-----------------------------|---|--|-----|------|-----------|------------------|
| BV _{DSS} | Drain-to-Source Breakdown Voltage | $V_{GS} = 0 \text{ V}, I_D = 1 \text{ mA}, T_J = 25^\circ\text{C}$ | 650 | – | – | V |
| | | $V_{GS} = 0 \text{ V}, I_D = 10 \text{ mA}, T_J = 150^\circ\text{C}$ | 700 | – | – | V |
| $\Delta V_{DSS}/\Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 20 \text{ mA}$, Referenced to 25°C | – | 0.61 | – | $^\circ\text{C}$ |
| I _{DSS} | Zero Gate Voltage Drain Current | $V_{DS} = 650 \text{ V}, V_{GS} = 0 \text{ V}$ | – | – | 10 | μA |
| | | $V_{DS} = 520 \text{ V}, T_C = 125^\circ\text{C}$ | – | 128 | – | μA |
| I _{GSS} | Gate-to-Body Leakage Current | $V_{DS} = 0 \text{ V}, V_{GS} = \pm 30 \text{ V}$ | – | – | ± 100 | nA |

ON CHARACTERISTICS

| | | | | | | |
|---------------------|--------------------------------------|---|-----|-----|-----|------------------|
| $V_{GS(\text{th})}$ | Drain-to-Source Breakdown Voltage | $V_{GS} = V_{DS}, I_D = 0.43 \text{ mA}$ | 3.0 | – | 5.0 | V |
| $R_{DS(\text{on})}$ | Static Drain-to-Source On Resistance | $V_{GS} = 10 \text{ V}, I_D = 10 \text{ A}$ | – | 158 | 190 | $\text{m}\Omega$ |
| g_{FS} | Forward Transconductance | $V_{GS} = 20 \text{ V}, I_D = 10 \text{ A}$ | – | 11 | – | S |

DYNAMIC CHARACTERISTICS

| | | | | | | |
|------------------------|-----------------------------------|--|---|------|---|----------|
| C_{iss} | Input Capacitance | $V_{DS} = 400 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$ | – | 1605 | – | pF |
| C_{oss} | Output Capacitance | | – | 32 | – | pF |
| $C_{oss(\text{eff.})}$ | Effective Output Capacitance | $V_{DS} = 0 \text{ to } 400 \text{ V}, V_{GS} = 0 \text{ V}$ | – | 314 | – | pF |
| $C_{oss(\text{er.})}$ | Energy Related Output Capacitance | $V_{DS} = 0 \text{ to } 400 \text{ V}, V_{GS} = 0 \text{ V}$ | – | 59 | – | pF |
| $Q_{g(\text{total})}$ | Total Gate Charge at 10 V | $V_{DS} = 400 \text{ V}, I_D = 10 \text{ A}, V_{GS} = 10 \text{ V}$ (Note 4) | – | 34 | – | nC |
| Q_{gs} | Gate-to-Source Gate Charge | | – | 11 | – | nC |
| Q_{gd} | Gate-to-Drain "Miller" Charge | | – | 13 | – | nC |
| ESR | Equivalent Series Resistance | $f = 1 \text{ MHz}$ | – | 2 | – | Ω |

SWITCHING CHARACTERISTICS, $V_{GS} = 10 \text{ V}$

| | | | | | | |
|---------------------|---------------------|--|---|----|---|----|
| $t_{d(\text{on})}$ | Turn-On Delay Time | $V_{DD} = 400 \text{ V}, I_D = 10 \text{ A}, V_{GS} = 10 \text{ V}, R_G = 4.7 \Omega$ (Note 4) | – | 19 | – | ns |
| t_r | Rise Time | | – | 13 | – | ns |
| $t_{d(\text{off})}$ | Turn-Off Delay Time | | – | 43 | – | ns |
| t_f | Fall Time | | – | 3 | – | ns |

SOURCE-DRAIN DIODE CHARACTERISTICS

| | | | | | | |
|-----------------|--|--|---|-----|-----|----|
| I _S | Maximum Continuous Source-to-Drain Diode Forward Current | – | – | 20 | A | |
| I _{SM} | Maximum Pulsed Source-to-Drain Diode Forward Current | – | – | 50 | A | |
| V _{SD} | Source-to-Drain Diode Forward Voltage | $V_{GS} = 0 \text{ V}, I_{SD} = 10 \text{ A}$ | – | – | 1.3 | V |
| t_{rr} | Reverse-Recovery Time | $V_{GS} = 0 \text{ V}, I_{SD} = 10 \text{ A}, dI/dt = 100 \text{ A}/\mu\text{s}$ | – | 68 | – | ns |
| Q _{rr} | Reverse-Recovery Charge | | – | 220 | – | 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.

TYPICAL CHARACTERISTICS

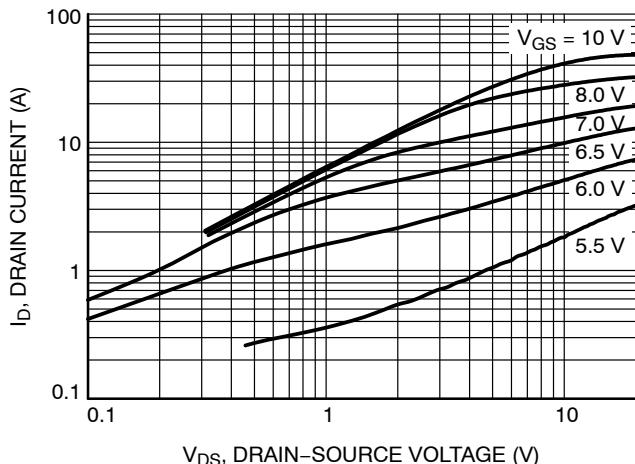


Figure 1. On-Region Characteristics
 25°C

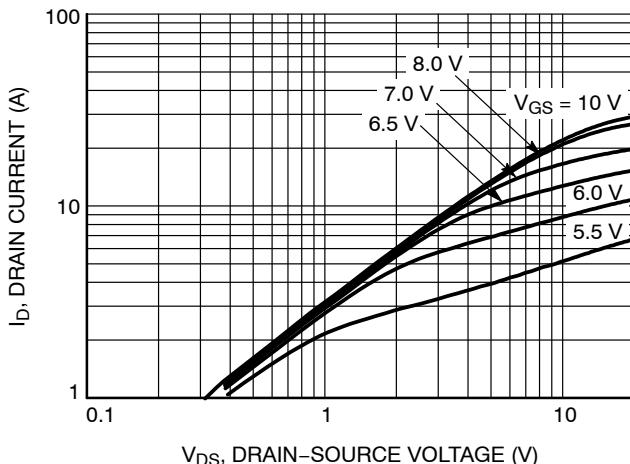


Figure 2. On-Region Characteristics
 150°C

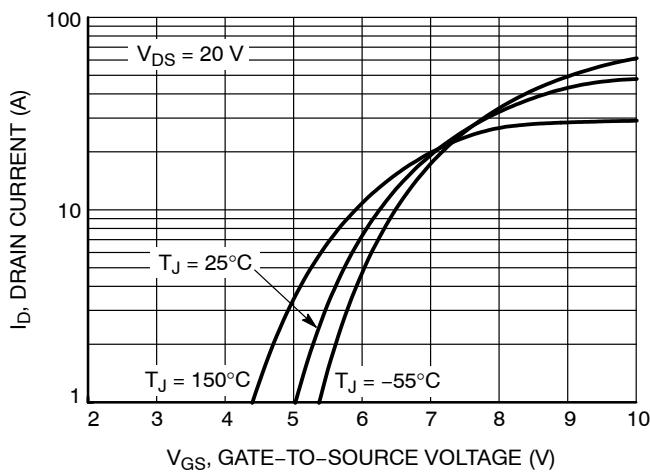


Figure 3. Transfer Characteristics

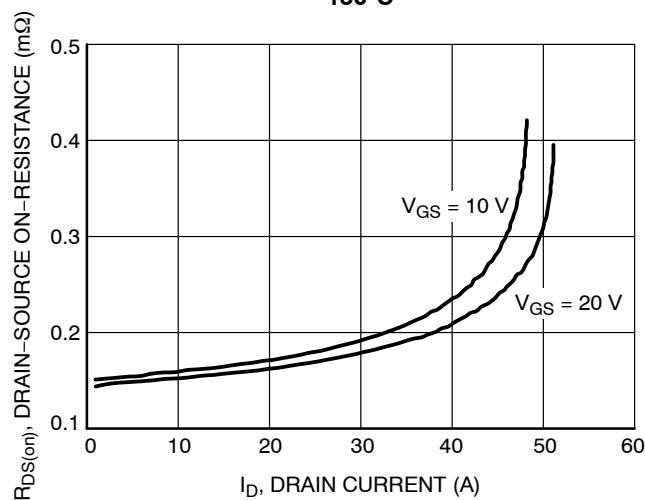


Figure 4. On-Resistance Variation vs. Drain Current and Gate Voltage

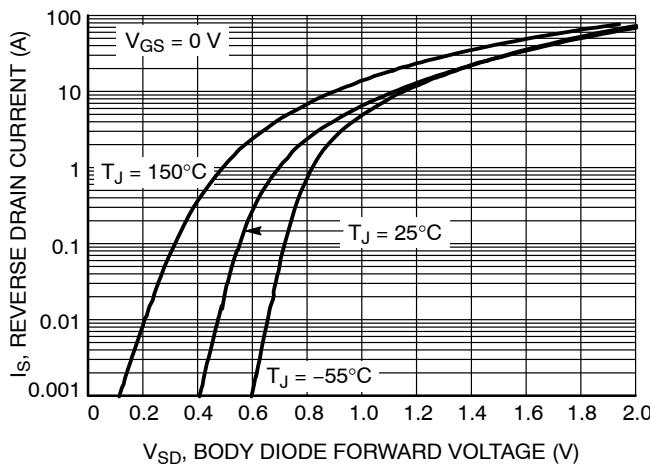


Figure 5. Body Diode Forward Voltage Variation vs. Source Current and Temperature

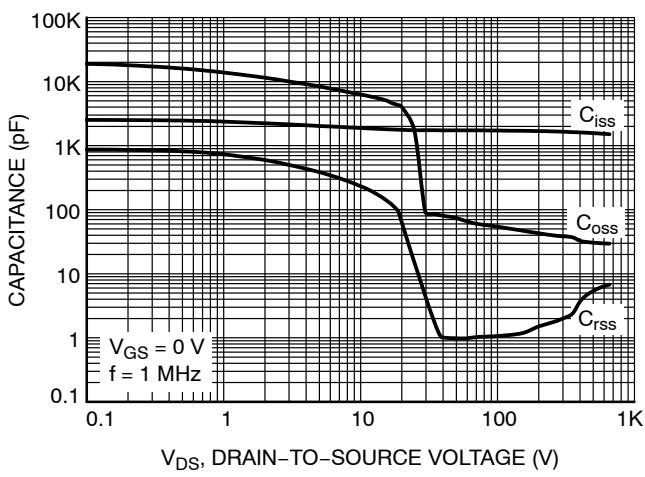
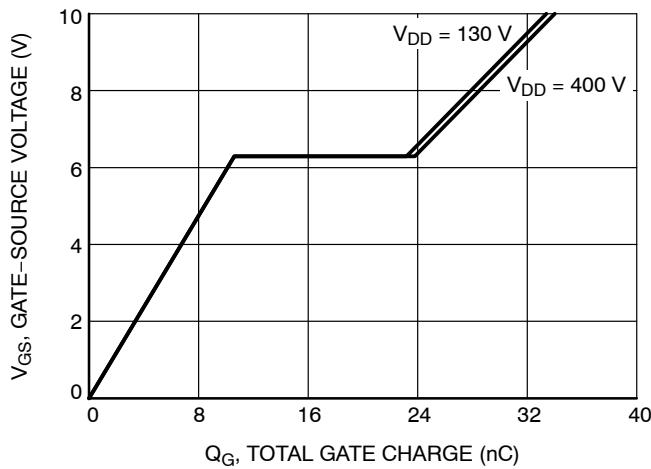
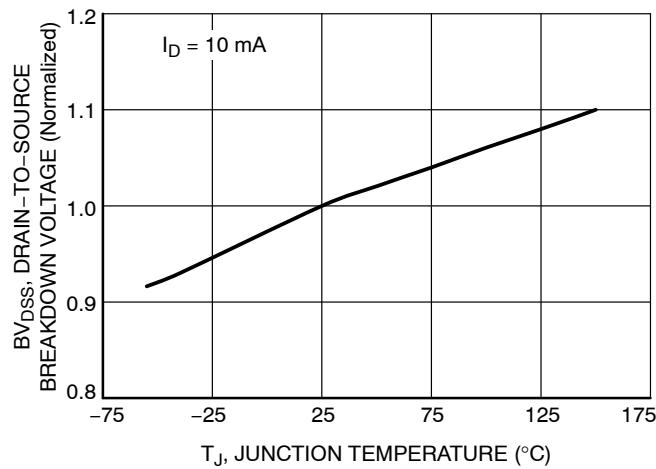
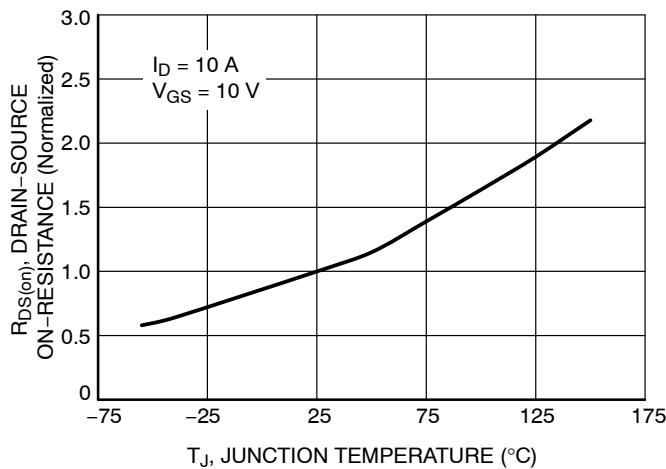
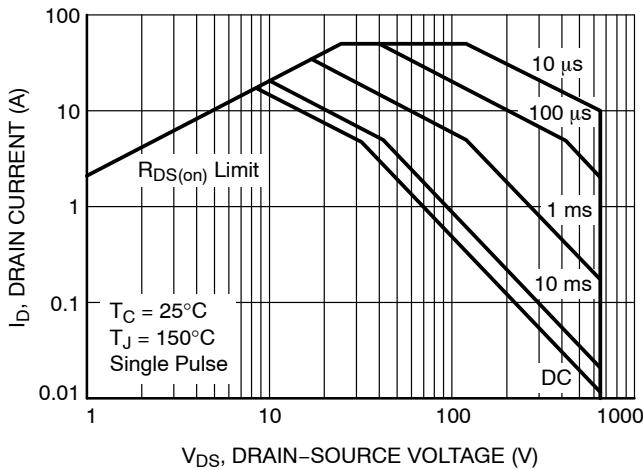
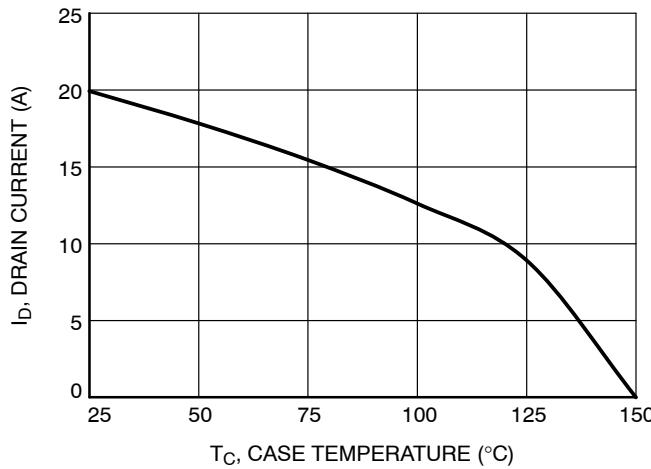
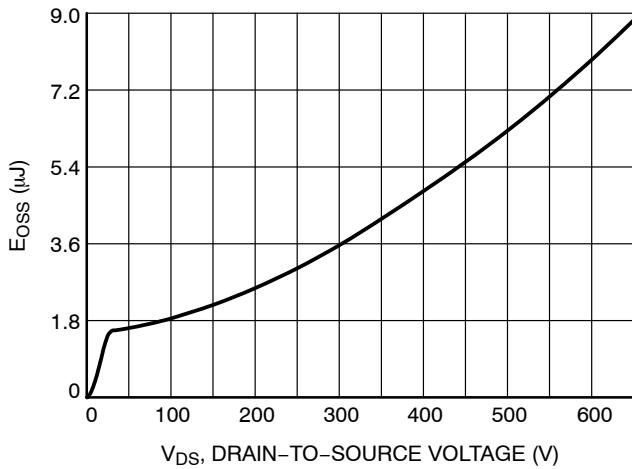


Figure 6. Capacitance Characteristics

TYPICAL CHARACTERISTICS

Figure 7. Gate Charge Characteristics

Figure 8. Breakdown Voltage Variation vs. Temperature

Figure 9. On-Resistance Variation vs. Temperature

Figure 10. Maximum Safe Operating Area

Figure 11. Maximum Drain Current vs. Case Temperature

Figure 12. E_{OSS} vs. Drain-to-Source Voltage

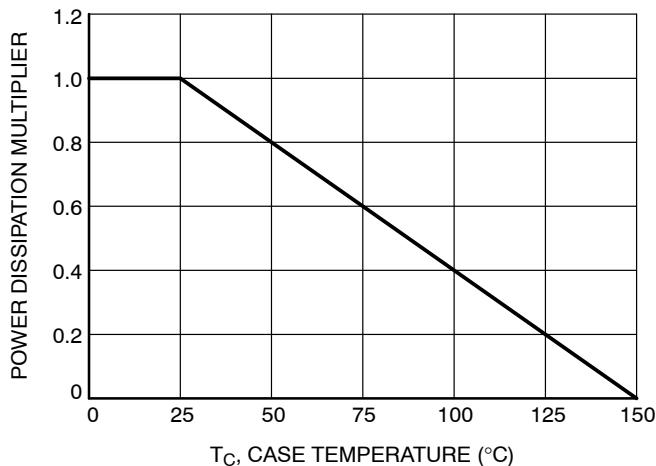
TYPICAL CHARACTERISTICS


Figure 13. Normalized Power Dissipation vs. Case Temperature

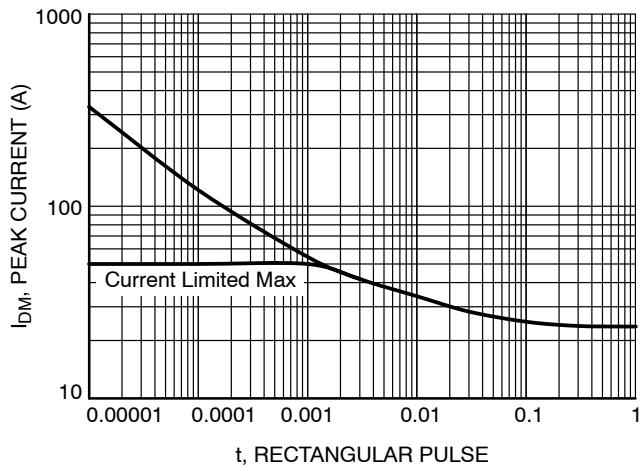


Figure 14. Peak Current Capability

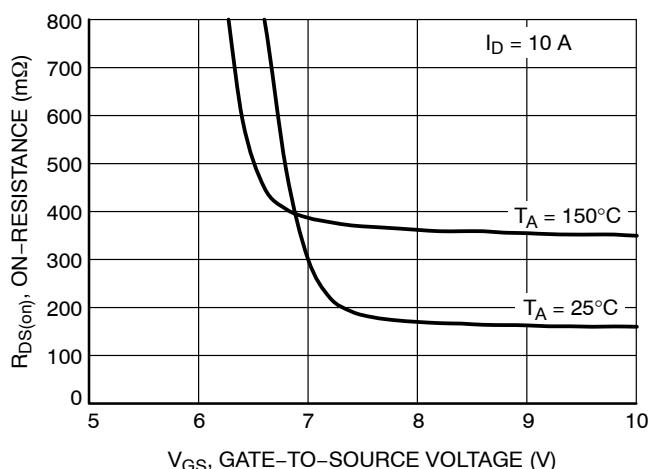


Figure 15. R_{DS(on)} vs. Gate Voltage

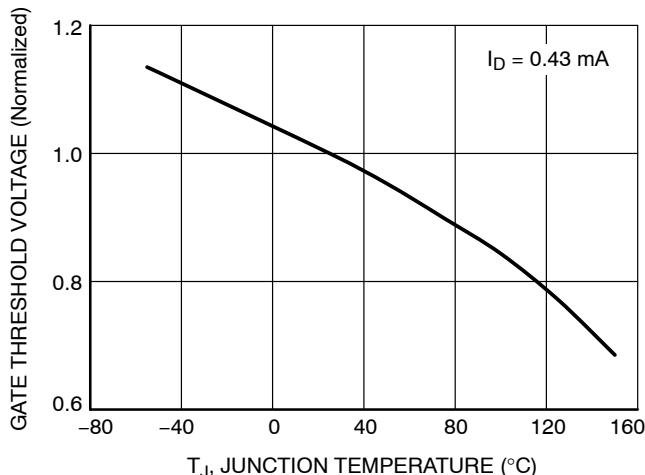


Figure 16. Normalized Gate Threshold Voltage vs. Temperature

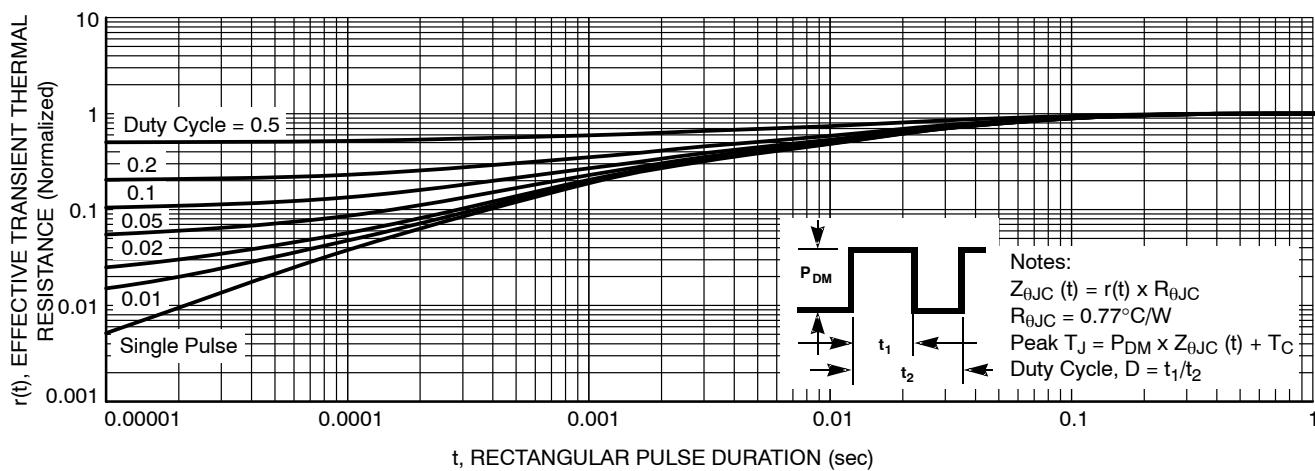


Figure 17. Transient Thermal Response

Notes:
 $Z_{\theta JC}(t) = r(t) \times R_{\theta JC}$
 $R_{\theta JC} = 0.77^{\circ}\text{C}/\text{W}$
 $\text{Peak } T_J = P_{DM} \times Z_{\theta JC}(t) + T_C$
 $\text{Duty Cycle, } D = t_1/t_2$

NVB190N65S3F

PACKAGE MARKING AND ORDERING INFORMATION

| Part Number | Top Marking | Package | Packing Method | Reel Size | Tape Width | Quantity |
|--------------|--------------|--------------------|--------------------------|-----------|------------|-----------|
| NVB190N65S3F | NVB190N65S3F | D ² PAK | Tape & Reel [†] | 330 mm | 24 mm | 800 Units |

[†]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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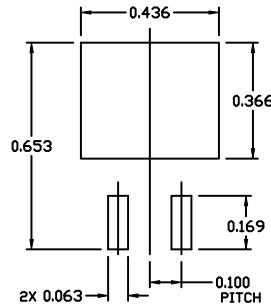
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D²PAK-3 (TO-263, 3-LEAD)

CASE 418AJ

ISSUE F

DATE 11 MAR 2021

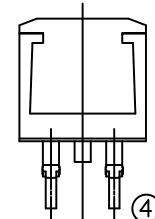
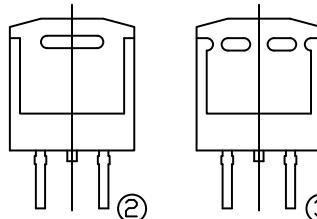
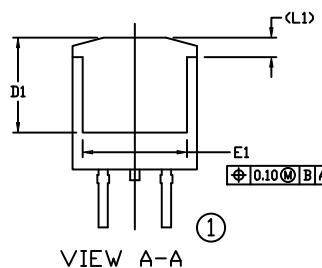
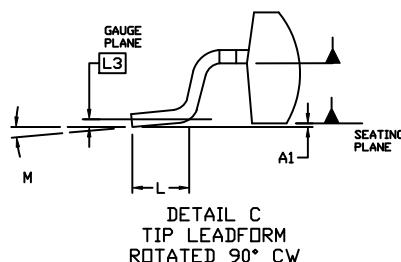
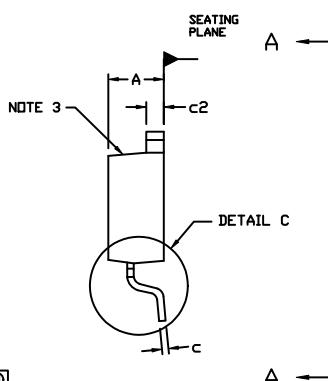
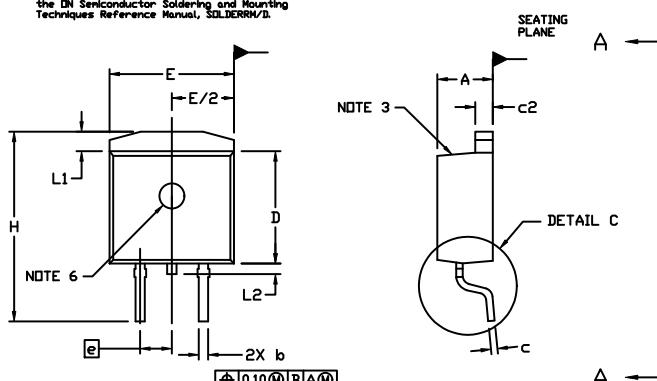
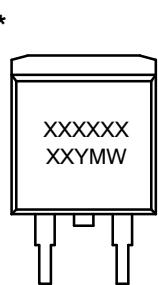
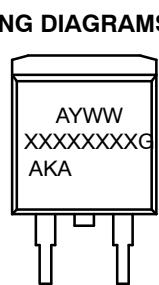
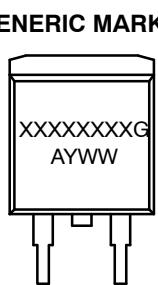
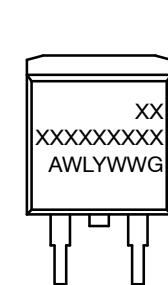
RECOMMENDED
MOUNTING FOOTPRINT

For additional information on our Pb-Free strategy and soldering details, please download the DN Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRAV2.

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: INCHES
3. CHAMFER OPTIONAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005 PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
5. THERMAL PAD CONTOUR IS OPTIONAL WITHIN DIMENSIONS E, L1, D1, AND E1.
6. OPTIONAL MOLD FEATURE.
7. ①, ② ... OPTIONAL CONSTRUCTION FEATURE CALL OUTS.

| DIM | INCHES | | MILLIMETERS | |
|-----|--------|-------|-------------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 0.160 | 0.190 | 4.06 | 4.83 |
| A1 | 0.000 | 0.010 | 0.00 | 0.25 |
| b | 0.020 | 0.039 | 0.51 | 0.99 |
| c | 0.012 | 0.029 | 0.30 | 0.74 |
| c2 | 0.045 | 0.065 | 1.14 | 1.65 |
| D | 0.330 | 0.380 | 8.38 | 9.65 |
| D1 | 0.260 | --- | 6.60 | --- |
| E | 0.380 | 0.420 | 9.65 | 10.67 |
| E1 | 0.245 | --- | 6.22 | --- |
| e | 0.100 | BSC | 2.54 | BSC |
| H | 0.575 | 0.625 | 14.60 | 15.88 |
| L | 0.070 | 0.110 | 1.78 | 2.79 |
| L1 | --- | 0.066 | --- | 1.68 |
| L2 | --- | 0.070 | --- | 1.78 |
| L3 | 0.010 | BSC | 0.25 | BSC |
| M | 0° | 8° | 0° | 8° |

VIEW A-A
OPTIONAL CONSTRUCTIONS

GENERIC MARKING DIAGRAMS*

XXXXXX = Specific Device Code

A = Assembly Location

WL = Wafer Lot

Y = Year

WW = Work Week

W = Week Code (SSG)

M = Month Code (SSG)

G = Pb-Free Package

AKA = Polarity Indicator

*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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