# [MOSFET](#) - Power, Single N-Channel, D2PAK-7L
## 650 V, 89 mΩ, 37 A

| $V_{(BR)DSS}$ | $R_{DS(ON)}$ MAX | $I_D$ MAX |
|---|---|---|
| 650 V | 89 mΩ @ 10 V | 37 A |

# NVBG089N65S3F

## Description

SUPERFET$^®$ 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$^®$ 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 @ $T_J$ = 150°C
- Typ. $R_{DS(on)}$ = 70 mΩ
- Ultra Low Gate Charge (Typ. $Q_g$ = 74 nC)
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)}$ = 668 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

Drain (TAB)

Gate (Pin 1)

Driver Source (Pin 2)

Power Source (Pins 3, 4, 5, 6, 7)

**N−CHANNEL MOSFET**

**D2PAK−7L**
**CASE 418BJ**

## MARKING DIAGRAM

VBG089
N65S3F
AYWWZZ

VBG089N65S3F = Specific Device Code
A     = Assembly Location
Y     = Year
WW   = Work Week
ZZ    = Lot Traceability

## ORDERING INFORMATION

**Table 1. ABSOLUTE MAXIMUM RATINGS** ($T_C = 25°C$ 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 Hz) | ±30 | |
| $I_D$ | Drain Current | – Continuous ($T_C = 25°C$) | 37 | A |
| | | – Continuous ($T_C = 100°C$) | 24.3 | |
| $I_{DM}$ | Drain Current | – Pulsed (Note 1) | 92 | A |
| $E_{AS}$ | Single Pulse Avalanche Energy (Note 2) | | 480 | mJ |
| $I_{AS}$ | Avalanche Current | | 4.7 | A |
| $E_{AR}$ | Repeated Avalanche Energy (Note 1) | | 2.92 | mJ |
| dv/dt | MOSFET dv/dt | | 100 | V/ns |
| | Peak Diode Recovery dv/dt (Note 3) | | 50 | |
| $P_D$ | Power Dissipation | $T_C = 25°C$ | 291 | W |
| | | – Derate Above 25°C | 2.33 | W/°C |
| $T_J$, $T_{stg}$ | Operating Junction and Storage Temperature Range | | −55 to 150 | °C |
| $T_L$ | Maximum Lead Temperature for Soldering, 1/8″ from Case for 5 Seconds | | 300 | °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. $I_{AS} = 4.7$ A, $R_G = 25$ Ω, starting $T_J = 25°C$.
3. $I_{SD} \leq 18.5$ A, di/dt $\leq 200$ A/μs, $V_{DD} \leq 400$ V, starting $T_C = 25°C$.

**Table 2. THERMAL RESISTANCE RATINGS**

| Symbol | Parameter | Max | Unit |
|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction−to−Case, Max. | 0.43 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction−to−Ambient, Max. | 40 | |

**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|--------|-----------|-----------------|-----|-----|-----|------|
| **OFF CHARACTERISTICS** | | | | | | |
| $BV_{DSS}$ | Drain−to−Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 1 mA, $T_J$ = 25°C | 650 | – | – | V |
| | | $V_{GS}$ = 0 V, $I_D$ = 10 mA, $T_J$ = 150°C | 700 | – | – | V |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 10 mA, Referenced to 25°C | – | 0.63 | – | V/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 650 V, $V_{GS}$ = 0 V | – | – | 10 | μA |
| | | $V_{DS}$ = 520 V, $T_C$ = 125°C | – | 11 | – | μA |
| $I_{GSS}$ | Gate−to−Body Leakage Current | $V_{GS}$ = ±30 V, $V_{DS}$ = 0 V | – | – | ±100 | nA |
| **ON CHARACTERISTICS** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 0.97 mA | 3 | – | 5 | V |
| $R_{DS(on)}$ | Static Drain−to−Source On Resistance | $V_{GS}$ = 10 V, $I_D$ = 18.5 A | – | 70 | 89 | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 20 V, $I_D$ = 18.5 A | – | 21 | – | S |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V, f = 1 MHz | – | 3598 | – | pF |
| $C_{oss}$ | Output Capacitance | | – | 64 | – | pF |
| $C_{oss(eff.)}$ | Effective Output Capacitance | $V_{DS}$ = 0 to 400 V, $V_{GS}$ = 0 V | – | 668 | – | pF |
| $C_{oss(er.)}$ | Energy Related Output Capacitance | $V_{DS}$ = 0 to 400 V, $V_{GS}$ = 0 V | – | 114 | – | pF |
| $Q_{g(total)}$ | Total Gate Charge at 10 V | $V_{DS}$ = 400 V, $I_D$ = 18.5 A, $V_{GS}$ = 10 V (Note 4) | – | 74 | – | nC |
| $Q_{gs}$ | Gate−to−Source Gate Charge | | – | 12 | – | nC |
| $Q_{gd}$ | Gate−to−Drain "Miller" Charge | | – | 29 | – | nC |
| ESR | Equivalent Series Resistance | F = 1 MHz | – | 1.3 | – | Ω |
| **SWITCHING CHARACTERISTICS, $V_{GS}$ = 10 V** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 400 V, $I_D$ = 18.5 A, $V_{GS}$ = 10 V, $R_G$ = 4.7 Ω (Note 4) | – | 34 | – | ns |
| $t_r$ | Rise Time | | – | 26 | – | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | – | 81 | – | ns |
| $t_f$ | Fall Time | | – | 5 | – | ns |
| **SOURCE−DRAIN DIODE CHARACTERISTICS** | | | | | | |
| $I_S$ | Maximum Continuous Source−to−Drain Diode Forward Current | | – | – | 37 | A |
| $I_{SM}$ | Maximum Pulsed Source−to−Drain Diode Forward Current | | – | – | 92 | A |
| $V_{SD}$ | Source−to−Drain Diode Forward Voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 18.5 A | – | – | 1.3 | V |
| $t_{rr}$ | Reverse−Recovery Time | $V_{GS}$ = 0 V, $I_{SD}$ = 18.5 A, $dI_F/dt$ = 100 A/μs | – | 103 | – | ns |
| $Q_{rr}$ | Reverse−Recovery Charge | | – | 414 | – | 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
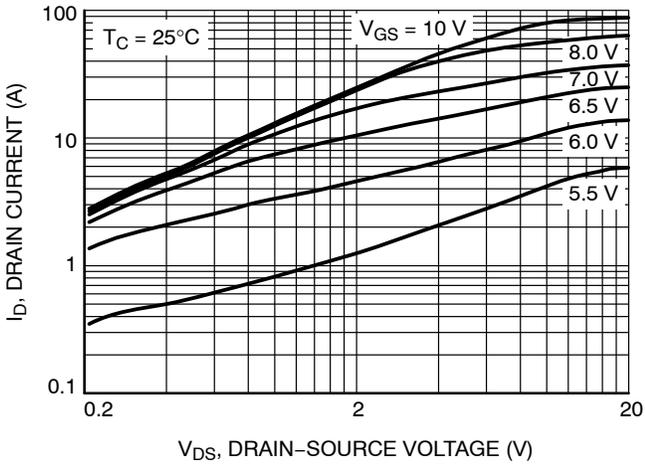
**Figure 1. On–Region Characteristics**
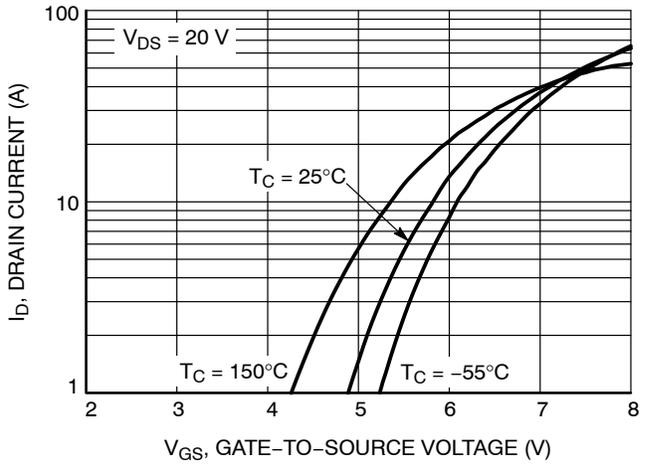
**Figure 2. Transfer Characteristics**
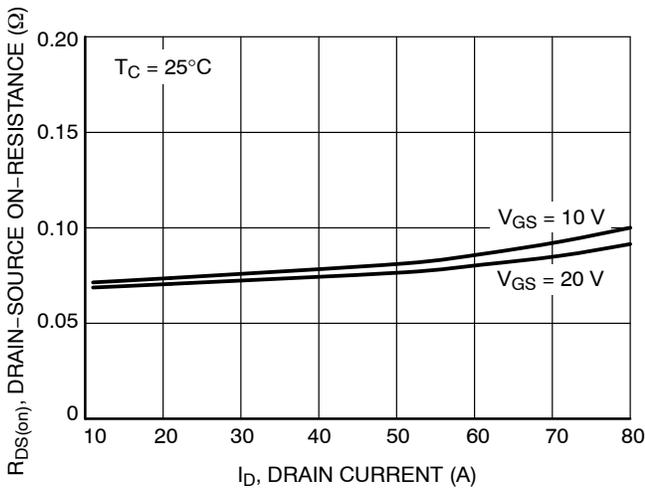
**Figure 3. On–Resistance Variation vs. Drain Current and Gate Voltage**
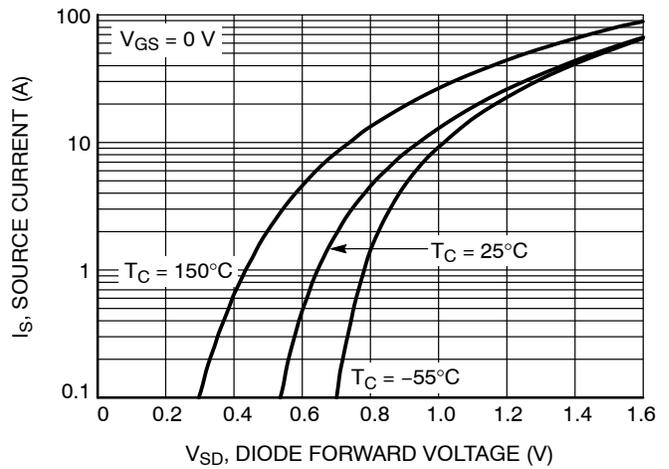
**Figure 4. Diode Forward Voltage vs. Source Current**
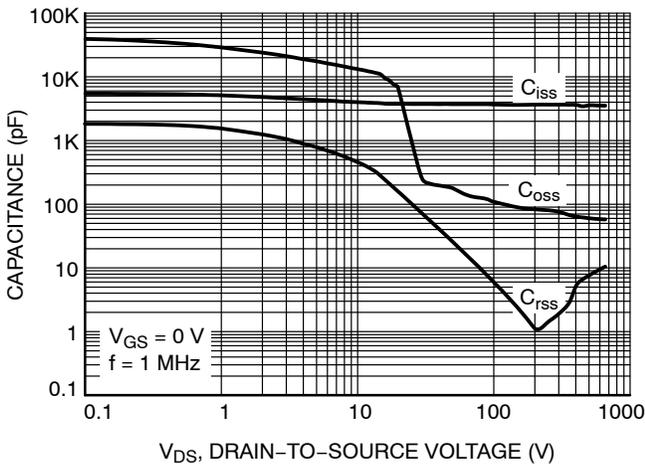
**Figure 5. Capacitance Characteristics**
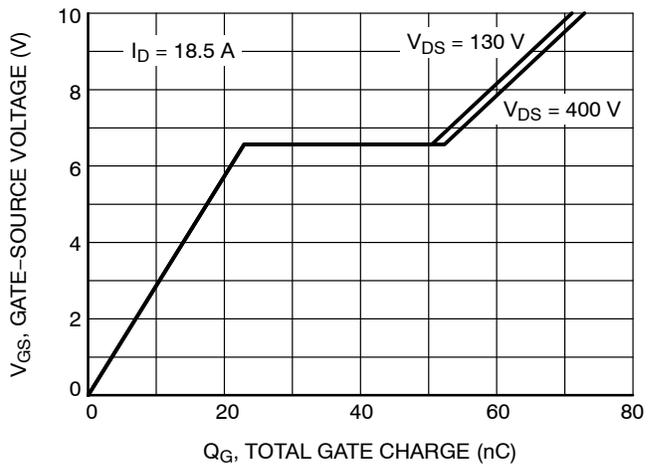
**Figure 6. Gate Charge Characteristics**

# TYPICAL CHARACTERISTICS
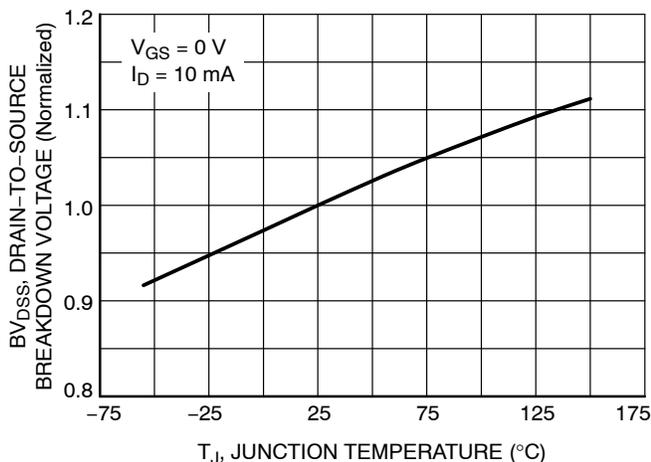


Figure 7. Breakdown Voltage Variation vs. Temperature
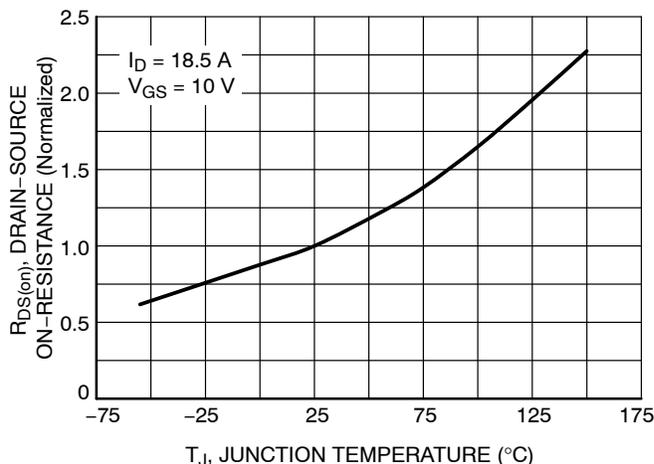


Figure 8. On−Resistance Variation vs. Temperature
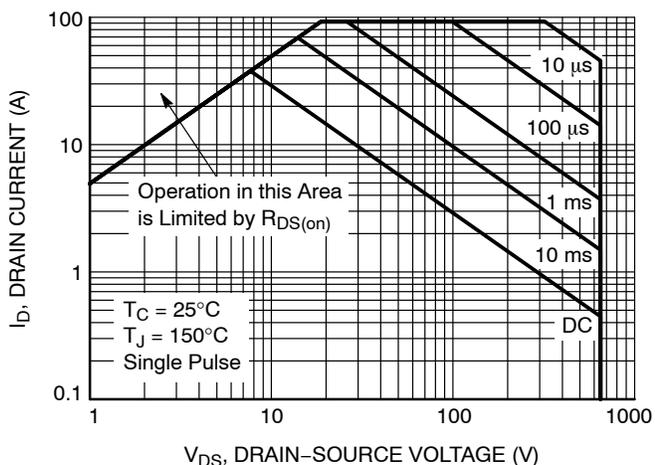


Figure 9. Maximum Safe Operating Area
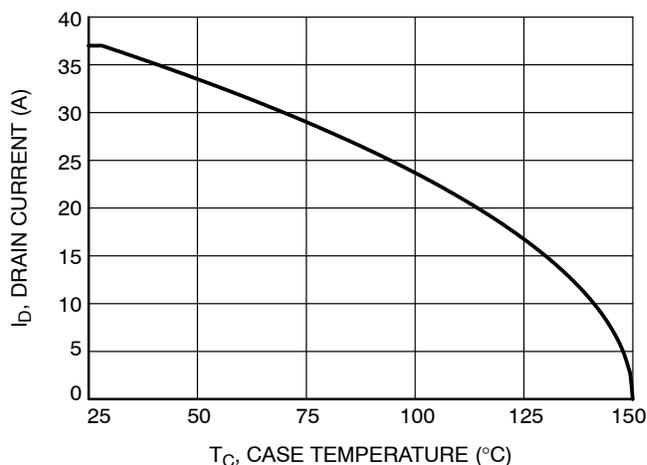


Figure 10. Maximum Drain Current vs. Case Temperature
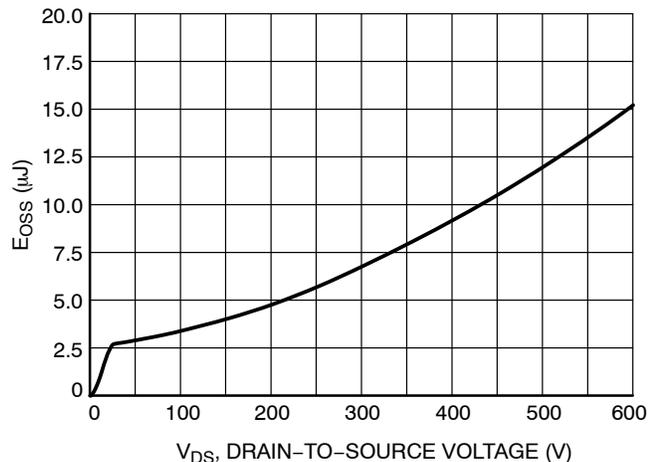


Figure 11. E$_{OSS}$ vs. Drain−to−Source Voltage

## TYPICAL CHARACTERISTICS



The y-axis is labeled "r(t), EFFECTIVE TRANSIENT THERMAL RESISTANCE (Normalized)" ranging from 0.001 to 10. The x-axis is labeled "t, RECTANGULAR PULSE DURATION (sec)" ranging from 0.00001 to 1. Curves are labeled: Duty Cycle = 0.5, 0.2, 0.1, 0.05, 0.02, 0.01, and Single Pulse.

Notes:
$Z_{\theta JC}(t) = r(t) \times R_{\theta JC}$
$R_{\theta JC} = 0.43°C/W$
Peak $T_J = P_{DM} \times Z_{\theta JC}(t) + T_C$
Duty Cycle, $D = t_1/t_2$
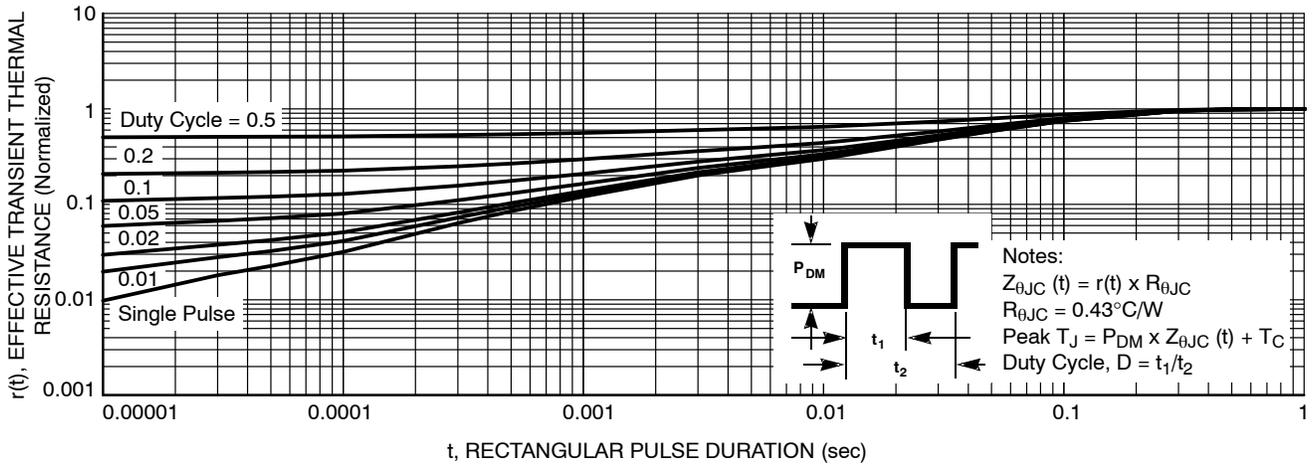
**Figure 12. Transient Thermal Response**

**DEVICE ORDERING INFORMATION**

| Device | Package | Shipping[†] |
|---|---|---|
| NVBG089N65S3F | D2PAK−7L | 800 / 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.
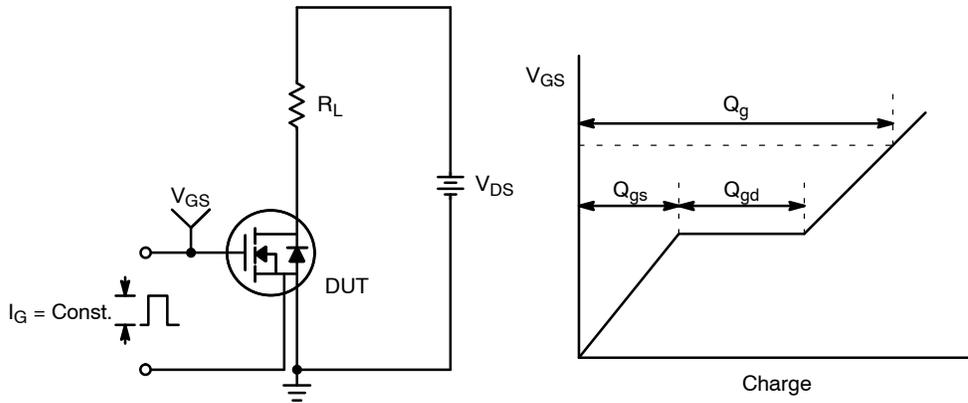
**Figure 13. Gate Charge Test Circuit & Waveform**
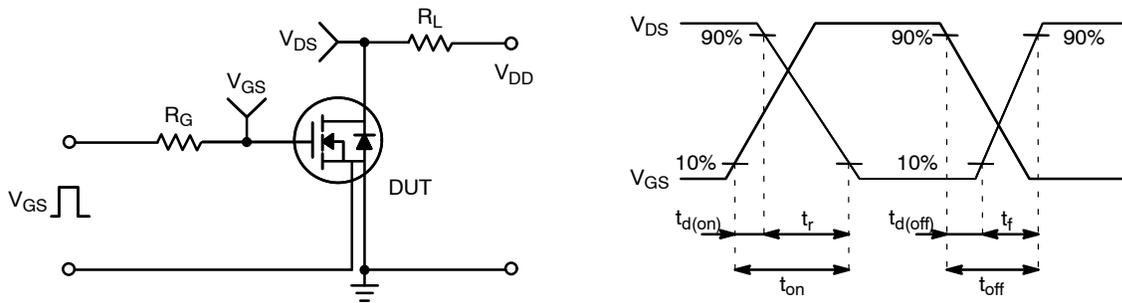


**Figure 14. Resistive Switching Test Circuit & Waveforms**
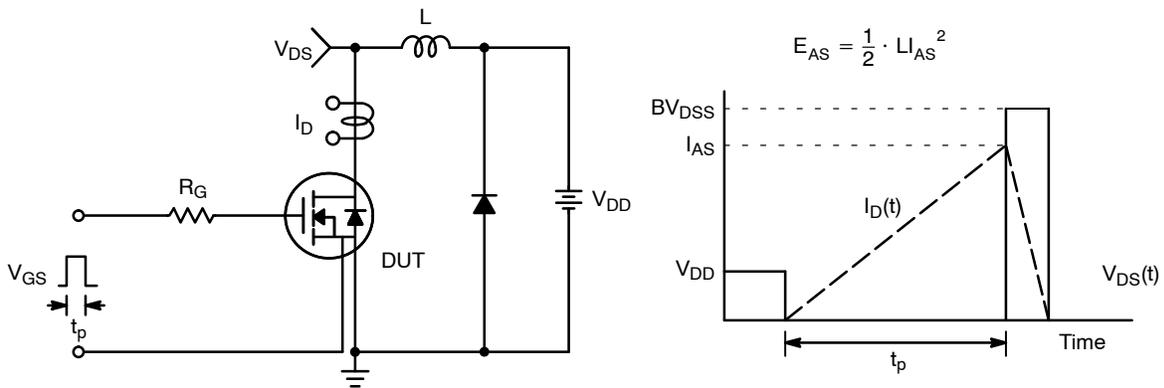


**Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms**
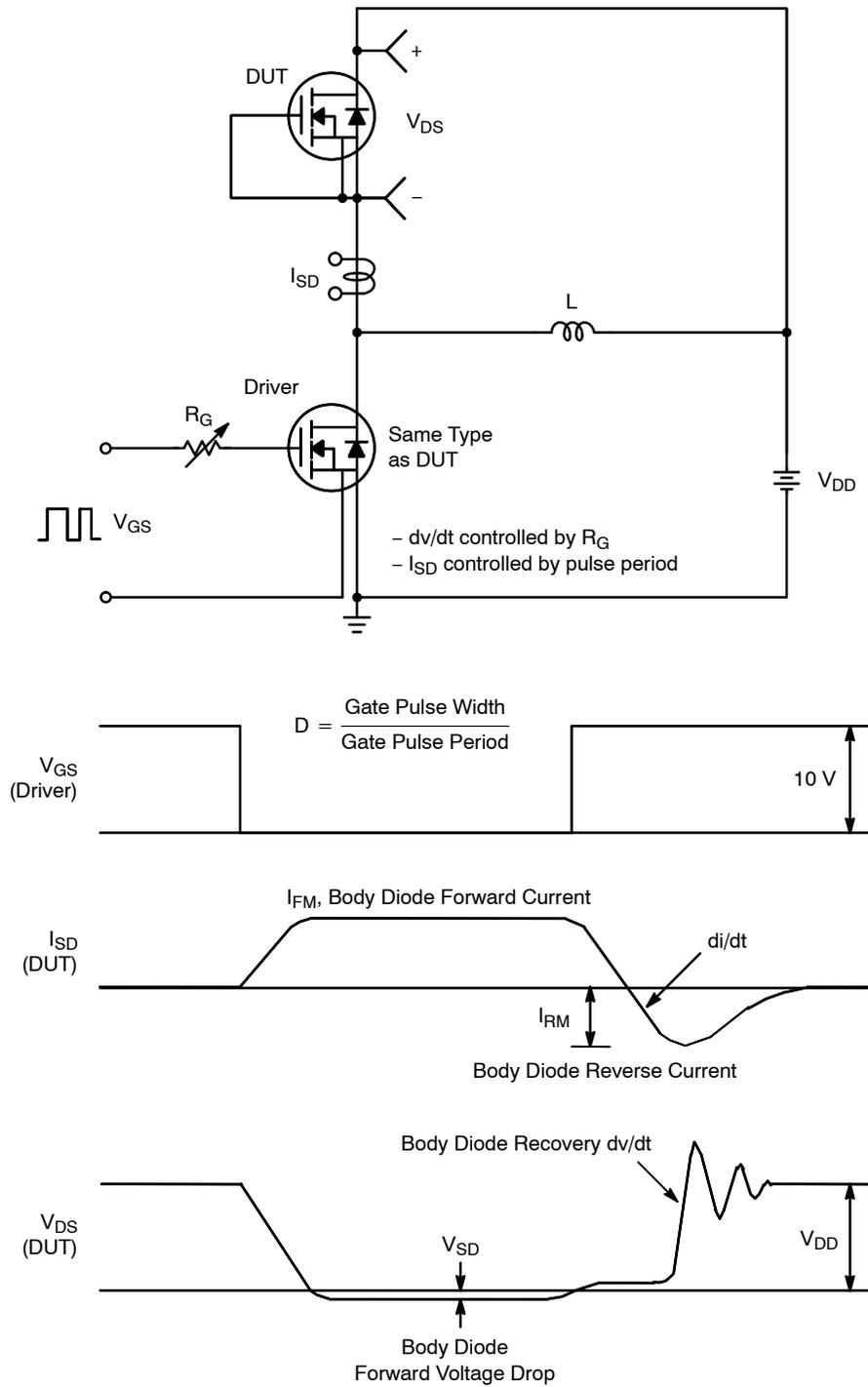
**Figure 16. Peak Diode Recovery dv/dt Test Circuit & Waveforms**

## PACKAGE DIMENSIONS

**D²PAK7 (TO−263−7L HV)**
CASE 418BJ
ISSUE B



LAND PATTERN RECOMMENDATION
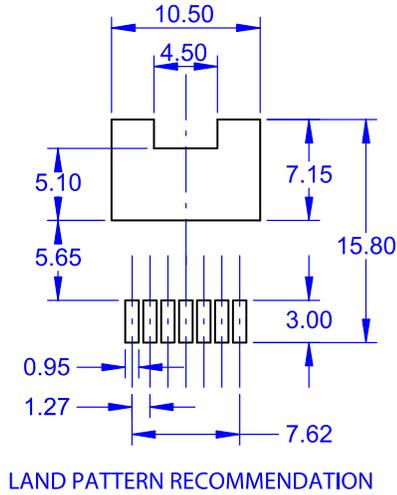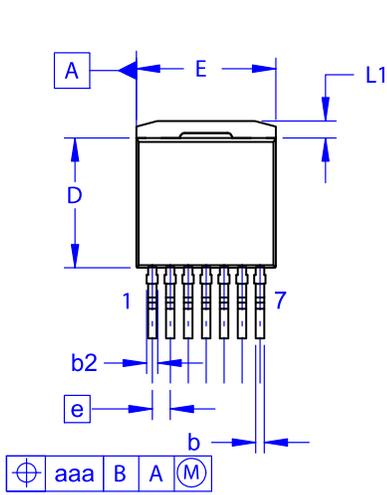
NOTES:

A. PACKAGE CONFORMS TO JEDEC TO-263
   VARIATION CB EXCEPT WHERE NOTED.
B. ALL DIMENSIONS ARE IN MILLIMETERS.
C. 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 |

DETAIL A
SCALE 2:1

**PUBLICATION ORDERING INFORMATION**

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