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MOSFET – Single N-Channel, SUPERFET® III, FRFET® 650 V, 46 A, 65 mΩ

NVHL065N65S3F

Features

- Ultra Low Gate Charge & Low Effective Output Capacitance
- Lower FOM ($R_{DS(on) max.} \times Q_g \text{ typ.} \& R_{DS(on) max.} \times E_{OSS}$)
- AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free and are RoHS Compliant

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

| Parameter | Symbol | Value | Unit |
|---|----------------|-------------|---------------------|
| Drain-to-Source Voltage | V_{DSS} | 650 | V |
| Gate-to-Source Voltage – DC | V_{GSS} | ± 30 | V |
| Gate-to-Source Voltage – AC ($f > 1 \text{ Hz}$) | V_{GSS} | ± 30 | V |
| Drain Current – Continuous ($T_C = 25^\circ\text{C}$) | I_D | 46 | A |
| Drain Current – Continuous ($T_C = 100^\circ\text{C}$) | I_D | 30 | A |
| Drain Current – Pulsed (Note 3) | I_{DM} | 115 | A |
| Power Dissipation ($T_C = 25^\circ\text{C}$) | P_D | 337 | W |
| Power Dissipation – Derate Above 25°C | P_D | 2.7 | W/ $^\circ\text{C}$ |
| Operating Junction and Storage Temperature Range | T_J, T_{STG} | -55 to +150 | $^\circ\text{C}$ |
| Single Pulsed Avalanche Energy (Note 4) | E_{AS} | 635 | mJ |
| Repetitive Avalanche Energy (Note 3) | E_{AR} | 3.37 | mJ |
| MOSFET dv/dt | dv/dt | 100 | V/ns |
| Peak Diode Recovery dv/dt (Note 5) | dv/dt | 50 | V/ns |
| Max. Lead Temperature for Soldering Purposes (1/8" from case for 5 s) | T_L | 300 | $^\circ\text{C}$ |

THERMAL CHARACTERISTICS

| Parameter | Symbol | Value | Unit |
|--|-----------------|-------|--------------------|
| Thermal Resistance, Junction-to-Case, Max. (Notes 1, 2) | $R_{\theta JC}$ | 0.37 | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Ambient, Max. (Notes 1, 2) | $R_{\theta JA}$ | 40 | |

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.

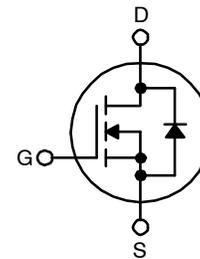
1. The entire application environment impacts the thermal resistance values shown. They are not constants and are only valid for the particular conditions noted.
2. Assembled to an infinite heatsink with perfect heat transfer from the case (assumes 0 K/W thermal interface).
3. Repetitive rating: pulse-width limited by maximum junction temperature.
4. $I_{AS} = 9 \text{ A}$, $R_G = 25 \Omega$, starting $T_J = 25^\circ\text{C}$.
5. $I_{SD} \leq 32.5 \text{ A}$, $di/dt \leq 200 \text{ A}/\mu\text{s}$, $V_{DD} \leq 400 \text{ V}$, starting $T_J = 25^\circ\text{C}$.



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| V_{DSS} | $R_{DS(ON) MAX}$ | $I_D MAX$ |
|-----------|------------------|-----------|
| 650 V | 65 mΩ @ 10 V | 46 A |



POWER MOSFET



TO-247-3LD
CASE 340CH

MARKING DIAGRAM



$\$Y$ = ON Semiconductor Logo
 $\&Z$ = Assembly Plant Code
 $\&3$ = Data Code (Year & Week)
 $\&K$ = Lot
 NVHL065N65S3F = Specific Device Code

ORDERING INFORMATION

| Device | Package | Shipping |
|---------------|-------------------------|-----------------|
| NVHL065N65S3F | TO-247-4LD (Pb-Free) | 30 Units / Tube |

NVHL065N65S3F

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

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

OFF CHARACTERISTICS

| | | | | | | |
|---|--------------------------------------|---|-----|-----|------|-------|
| Drain-to-Source Breakdown Voltage | BV _{DSS} | V _{GS} = 0 V, I _D = 1 mA, T _J = 25°C | 650 | | | V |
| Drain-to-Source Breakdown Voltage | BV _{DSS} | V _{GS} = 0 V, I _D = 10 mA, T _J = 150°C | 700 | | | V |
| Breakdown Voltage Temperature Coefficient | $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | I _D = 15 mA, Referenced to 25°C | | 630 | | mV/°C |
| Zero Gate Voltage Drain Current | I _{DSS} | V _{GS} = 0 V, V _{DS} = 650 V | | | 10 | μA |
| | | V _{DS} = 520 V, T _C = 125°C | | 153 | | |
| Gate-to-Body Leakage Current | I _{GSS} | V _{GS} = ±30 V, V _{DS} = 0 V | | | ±100 | nA |

ON CHARACTERISTICS

| | | | | | | |
|--------------------------------------|--|---|-----|------|-----|-------|
| Gate Threshold Voltage | V _{GS(th)} | V _{GS} = V _{DS} , I _D = 1.3 mA | 3.0 | | 5.0 | V |
| Threshold Temperature Coefficient | $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | V _{GS} = V _{DS} , I _D = 1.3 mA | | -8.6 | | mV/°C |
| Static Drain-to-Source On Resistance | R _{DS(on)} | V _{GS} = 10 V, I _D = 23 A | | 54 | 65 | mΩ |
| Forward Transconductance | g _{FS} | V _{DS} = 20 V, I _D = 23 A | | 31 | | S |

DYNAMIC CHARACTERISTICS

| | | | | | | |
|-----------------------------------|------------------------|--|--|------|--|----|
| Input Capacitance | C _{iss} | V _{GS} = 0 V, V _{DS} = 400 V, f = 1 MHz | | 4075 | | pF |
| Output Capacitance | C _{oss} | | | 95 | | |
| Reverse Transfer Capacitance | C _{rss} | | | 11 | | |
| Effective Output Capacitance | C _{oss(eff.)} | V _{DS} = 0 V to 400 V, V _{GS} = 0 V | | 876 | | pF |
| Energy Related Output Capacitance | C _{oss(er.)} | V _{DS} = 0 V to 400 V, V _{GS} = 0 V | | 160 | | pF |
| Total Gate Charge at 10 V | Q _{G(TOT)} | V _{GS} = 10 V, V _{DS} = 400 V, I _D = 23 A (Note 6) | | 98 | | nC |
| Gate-to-Source Gate Charge | Q _{GS} | | | 30 | | |
| Gate-to-Drain "Miller" Charge | Q _{GD} | | | 38 | | |
| Equivalent Series Resistance | ESR | f = 1 MHz | | 1.5 | | Ω |

SWITCHING CHARACTERISTICS

| | | | | | | |
|---------------------|---------------------|---|--|----|--|----|
| Turn-On Delay Time | t _{d(on)} | V _{GS} = 10 V, V _{DD} = 400 V, I _D = 23 A, R _g = 2.7 Ω (Note 6) | | 34 | | ns |
| Turn-On Rise Time | t _r | | | 31 | | ns |
| Turn-Off Delay Time | t _{d(off)} | | | 78 | | ns |
| Turn-Off Fall Time | t _f | | | 16 | | ns |

SOURCE-DRAIN DIODE CHARACTERISTICS

| | | | | | | |
|--|-----------------|--|--|-----|-----|----|
| Maximum Continuous Source-to-Drain Diode Forward Current | I _S | V _{GS} = 0 V | | | 46 | A |
| Maximum Pulsed Source-to-Drain Diode Forward Current | I _{SM} | V _{GS} = 0 V | | | 115 | A |
| Source-to-Drain Diode Forward Voltage | V _{SD} | V _{GS} = 0 V, I _{SD} = 23 A | | | 1.3 | V |
| Reverse Recovery Time | t _{rr} | V _{GS} = 0 V, dI _F /dt = 100 A/μs, I _{SD} = 23 A | | 116 | | ns |
| Charge Time | t _a | | | 90 | | |
| Discharge Time | t _b | | | 24 | | |
| Reverse Recovery Charge | Q _{rr} | | | 488 | | |

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.

6. Essentially independent of operating temperature typical characteristics.

TYPICAL PERFORMANCE CHARACTERISTICS

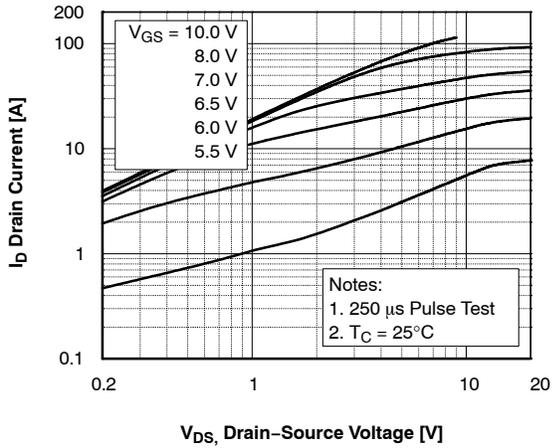


Figure 1. On-Region Characteristics

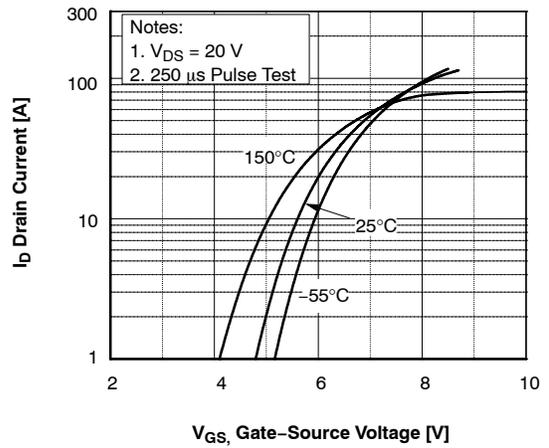


Figure 2. Transfer Characteristics

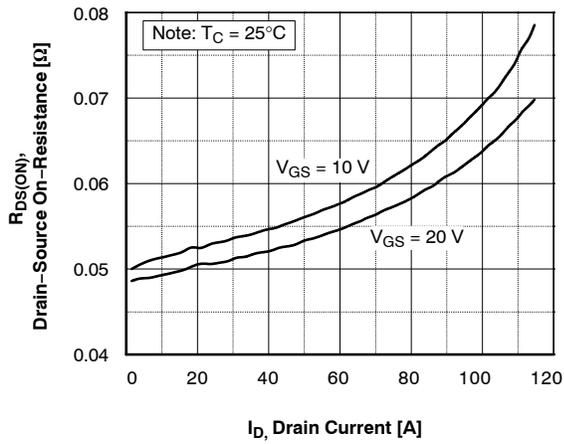


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

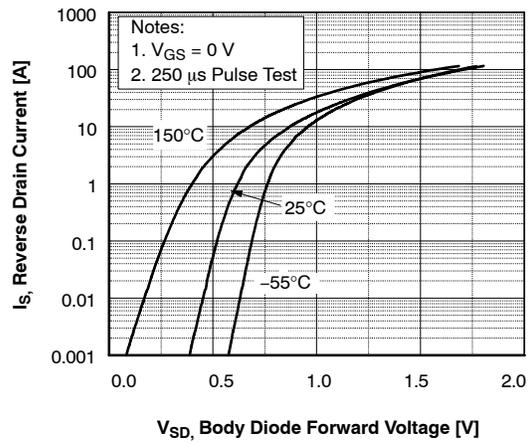


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

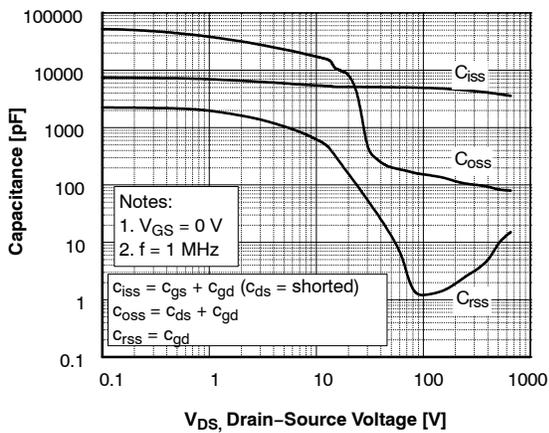


Figure 5. Capacitance Characteristics

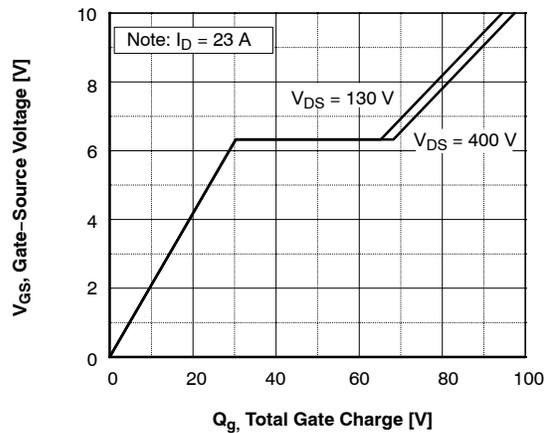


Figure 6. Gate Charge Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

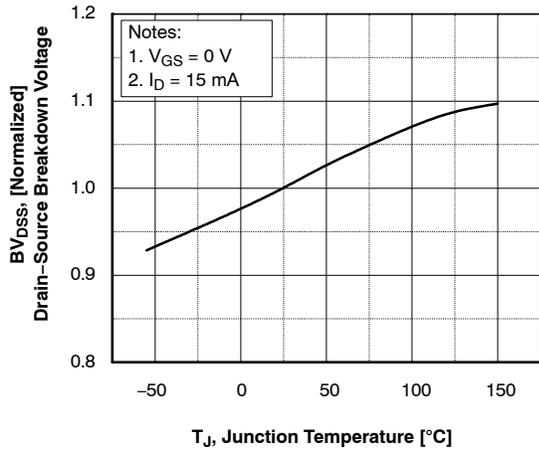


Figure 7. Breakdown Voltage Variation vs. Temperature

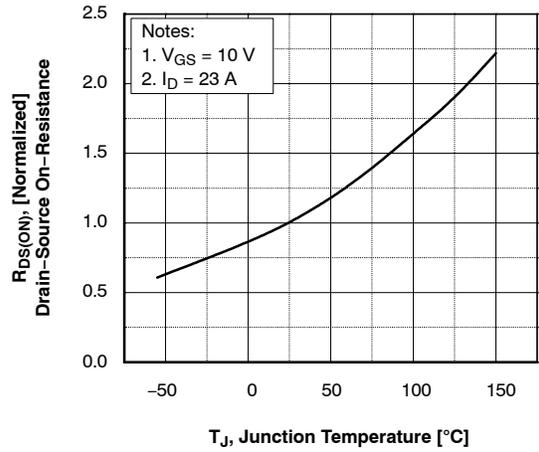


Figure 8. On-Resistance Variation vs. Temperature

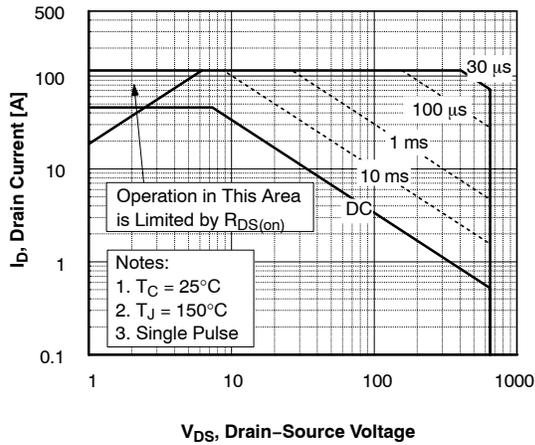


Figure 9. Maximum Safe Operating Area

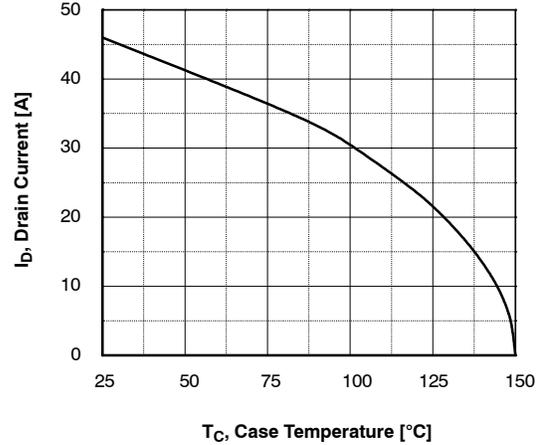


Figure 10. Maximum Drain Current vs. Case Temperature

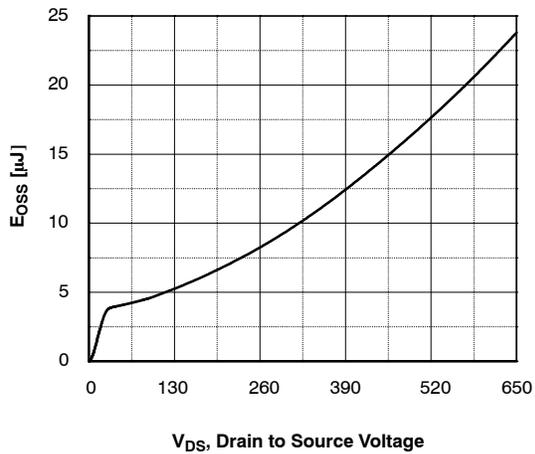


Figure 11. E_{OSS} vs. Drain to Source Voltage

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

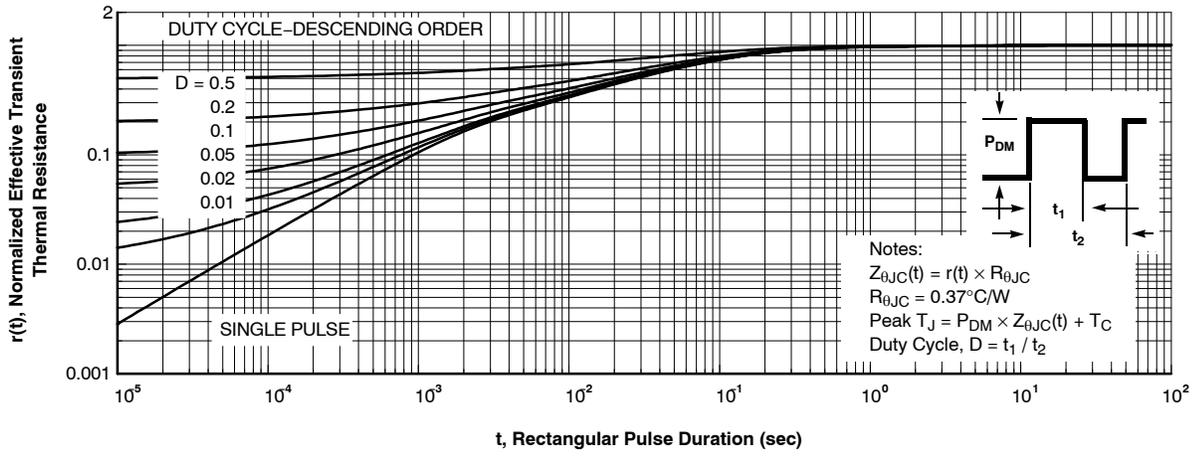


Figure 12. Transient Thermal Response Curve

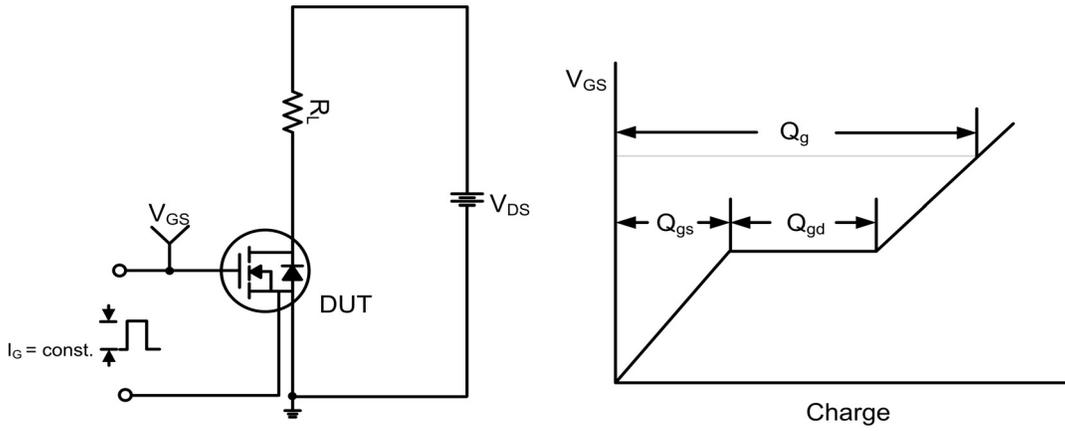


Figure 13. Gate Charge Test Circuit & Waveform

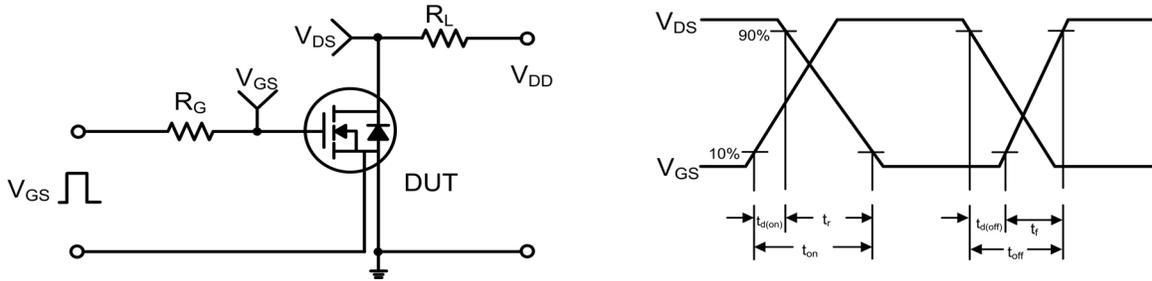


Figure 14. Resistive Switching Test Circuit & Waveforms

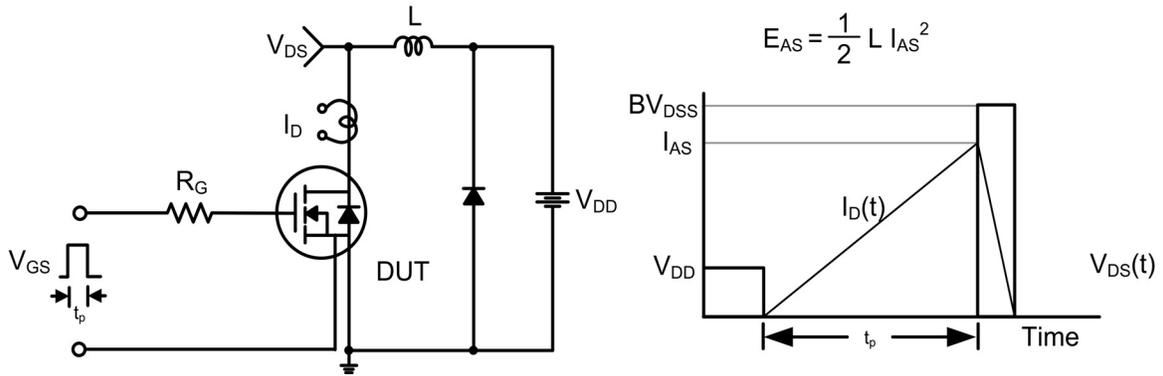


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

NVHL065N65S3F

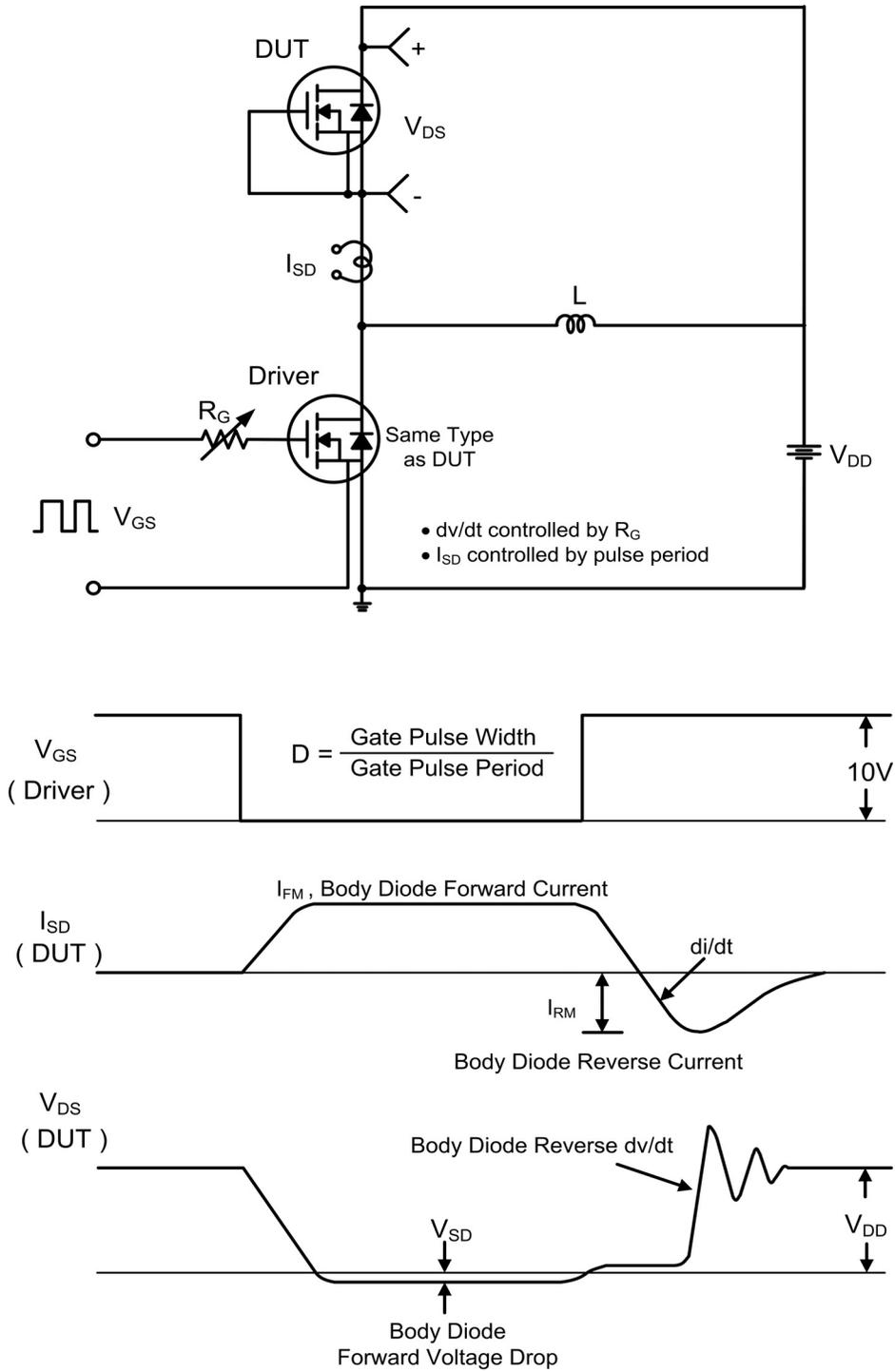
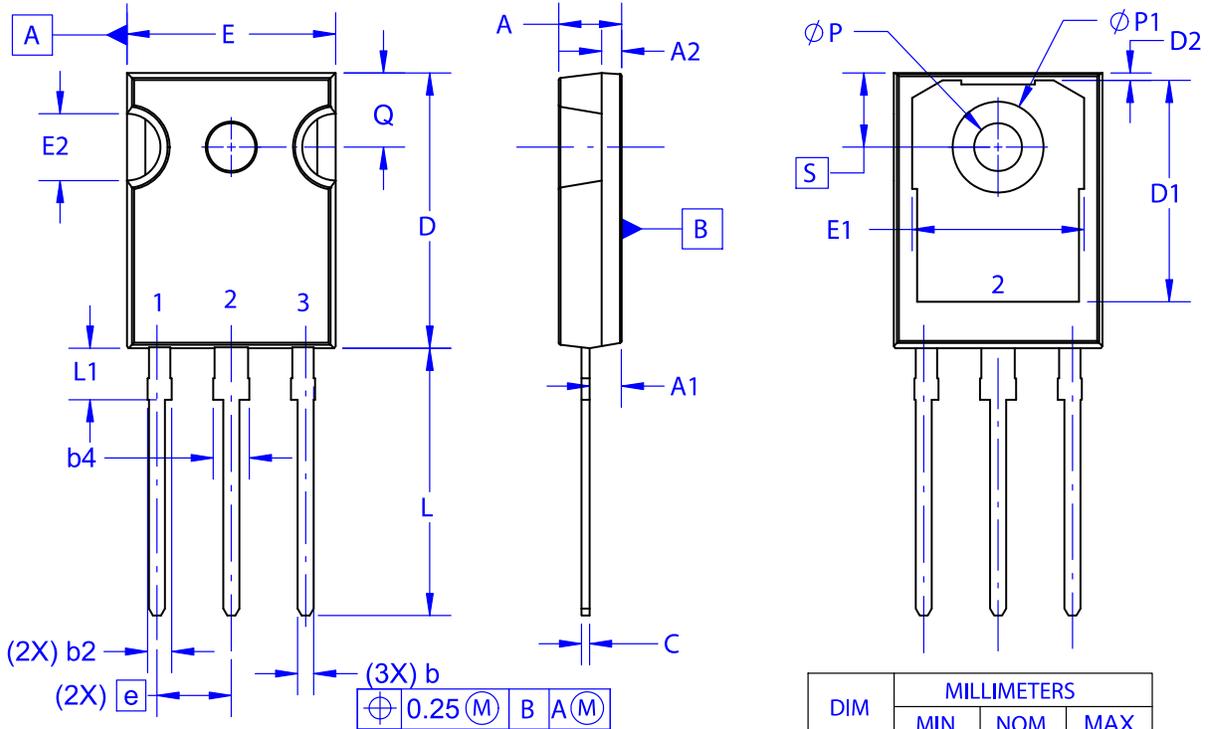


Figure 16. Peak Diode Recovery dv/dt Test Circuit & Waveforms

NVHL065N65S3F

PACKAGE DIMENSIONS

TO-247-4LD
CASE 340CH
ISSUE A



NOTES: UNLESS OTHERWISE SPECIFIED.

- A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DRAWING CONFORMS TO ASME Y14.5 - 2009.
- D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
- E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

| DIM | MILLIMETERS | | |
|-----|-------------|-------|-------|
| | MIN | NOM | MAX |
| A | 4.58 | 4.70 | 4.82 |
| A1 | 2.29 | 2.475 | 2.66 |
| A2 | 1.40 | 1.50 | 1.60 |
| D | 20.32 | 20.57 | 20.82 |
| E | 15.37 | 15.62 | 15.87 |
| E2 | 4.96 | 5.08 | 5.20 |
| e | ~ | 5.56 | ~ |
| L | 19.75 | 20.00 | 20.25 |
| L1 | 3.69 | 3.81 | 3.93 |
| ØP | 3.51 | 3.58 | 3.65 |
| Q | 5.34 | 5.46 | 5.58 |
| S | 5.34 | 5.46 | 5.58 |
| b | 1.17 | 1.26 | 1.35 |
| b2 | 1.53 | 1.65 | 1.77 |
| b4 | 2.42 | 2.54 | 2.66 |
| c | 0.51 | 0.61 | 0.71 |
| D1 | 13.08 | ~ | ~ |
| D2 | 0.51 | 0.93 | 1.35 |
| E1 | 12.81 | ~ | ~ |
| ØP1 | 6.61 | 6.73 | 6.85 |

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