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# MOSFET – Power, N-Channel, SUPERFET<sup>®</sup> III, Easy Drive

## 650 V, 260 mΩ, 12 A



ON Semiconductor<sup>®</sup>

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## NVD260N65S3

### Features

- Ultra Low Gate Charge & Low Effective Output Capacitance
- Lower FOM ( $R_{DS(on) max.} \times Q_{g typ.} \& R_{DS(on) max.} \times E_{OSS}$ )
- 100% Avalanche Tested
- 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	$V_{GSS}$	$\pm 30$	V
Gate-to-Source Voltage – AC ( $f > 1\text{ Hz}$ )	$V_{GSS}$	$\pm 30$	V
Drain Current – Continuous ( $T_C = 25^\circ\text{C}$ )	$I_D$	12	A
Drain Current – Continuous ( $T_C = 100^\circ\text{C}$ )	$I_D$	7.6	A
Drain Current – Pulsed (Note 3)	$I_{DM}$	30	A
Power Dissipation ( $T_C = 25^\circ\text{C}$ )	$P_D$	90	W
Power Dissipation – Derate Above $25^\circ\text{C}$	$P_D$	0.72	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)	$E_{AS}$	57	mJ
Repetitive Avalanche Energy (Note 3)	$E_{AR}$	0.9	mJ
MOSFET $dv/dt$	$dv/dt$	100	V/ns
Peak Diode Recovery $dv/dt$ (Note 5)	$dv/dt$	20	V/ns
Max. Lead Temperature for Soldering Purposes (1/8" from case for 5 s)	$T_L$	300	$^\circ\text{C}$

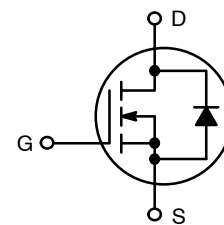
### THERMAL CHARACTERISTICS

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case, Max. (Notes 1, 2)	$R_{\theta JC}$	1.39	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Ambient, Max. (Notes 1, 2, 6)	$R_{\theta JA}$	40	

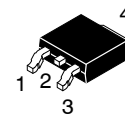
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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.  $I_{AS} = 2.3\text{ A}$ ,  $R_G = 25\ \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
5.  $I_{SD} \leq 6\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq 400\text{ V}$ , starting  $T_J = 25^\circ\text{C}$ .
6. Device on 1 in<sup>2</sup> pad 2 oz copper pad on 1.5 x 1.5 in. board of FR-4 material.

$V_{DSS}$	$R_{DS(on) MAX}$	$I_D MAX$
650 V	260 mΩ @ 10 V	12 A

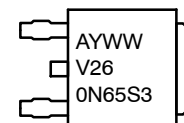


POWER MOSFET



DPAK  
CASE 369C

### MARKING DIAGRAM



A = Assembly Location  
Y = Year  
WW = Work Week  
V260N65S3 = Specific Device Code

### ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
NVD260N65S3	DPAK3 (Pb-Free)	2500 / 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 Specification Brochure, BRD8011/D.

# NVD260N65S3

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 25^\circ\text{C}$	650			V
Drain-to-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 150^\circ\text{C}$	700			V
Breakdown Voltage Temperature Coefficient	$\Delta BV_{DSS}/\Delta T_J$	$I_D = 1\text{ mA}$ , Referenced to $25^\circ\text{C}$		660		$\text{mV}/^\circ\text{C}$
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}, V_{DS} = 650\text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 520\text{ V}, T_C = 125^\circ\text{C}$		0.77		
Gate-to-Body Leakage Current	$I_{GSS}$	$V_{GS} = \pm 30\text{ V}, V_{DS} = 0\text{ V}$			$\pm 100$	nA

### ON CHARACTERISTICS

Gate Threshold Voltage	$V_{GS(th)}$	$V_{GS} = V_{DS}, I_D = 0.29\text{ mA}$	2.5		4.5	V
Threshold Temperature Coefficient	$\Delta V_{GS(th)}/\Delta T_J$	$V_{GS} = V_{DS}, I_D = 0.29\text{ mA}$		-8.9		$\text{mV}/^\circ\text{C}$
Static Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 6\text{ A}$		217	260	$\text{m}\Omega$
Forward Transconductance	$g_{FS}$	$V_{DS} = 20\text{ V}, I_D = 6\text{ A}$		7.3		S

### DYNAMIC CHARACTERISTICS

Input Capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}, V_{DS} = 400\text{ V}, f = 1\text{ MHz}$		1042		$\text{pF}$
Output Capacitance	$C_{oss}$			22.5		
Reverse Transfer Capacitance	$C_{rss}$			3.8		
Effective Output Capacitance	$C_{oss(eff.)}$	$V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$		225		$\text{pF}$
Energy Related Output Capacitance	$C_{oss(er.)}$	$V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$		37.5		$\text{pF}$
Total Gate Charge at 10 V	$Q_{G(TOT)}$	$V_{GS} = 10\text{ V}, V_{DS} = 400\text{ V}, I_D = 6\text{ A}$ (Note 7)		23.5		$\text{nC}$
Threshold Gate Charge	$Q_{G(TH)}$			3.8		
Gate-to-Source Gate Charge	$Q_{GS}$			6.3		
Gate-to-Drain "Miller" Charge	$Q_{GD}$			9.8		
Equivalent Series Resistance	ESR	$f = 1\text{ MHz}$		8.1		$\Omega$

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(on)}$	$V_{GS} = 10\text{ V}, V_{DD} = 400\text{ V},$ $I_D = 6\text{ A}, R_g = 4.7\ \Omega$ (Note 7)		17.2		ns
Turn-On Rise Time	$t_r$			13.9		
Turn-Off Delay Time	$t_{d(off)}$			48.3		
Turn-Off Fall Time	$t_f$			8.3		

### SOURCE-DRAIN DIODE CHARACTERISTICS

Maximum Continuous Source-to-Drain Diode Forward Current	$I_S$	$V_{GS} = 0\text{ V}$			12	A
Maximum Pulsed Source-to-Drain Diode Forward Current	$I_{SM}$	$V_{GS} = 0\text{ V}$			30	A
Source-to-Drain Diode Forward Voltage	$V_{SD}$	$V_{GS} = 0\text{ V}, I_{SD} = 6\text{ A}$			1.2	V
Reverse Recovery Time	$t_{rr}$	$V_{GS} = 0\text{ V}, dI_F/dt = 100\text{ A}/\mu\text{s},$ $I_{SD} = 6\text{ A}$		232		ns
Charge Time	$t_a$			220		
Discharge Time	$t_b$			13		
Reverse Recovery Charge	$Q_{rr}$			2837		

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.

7. Essentially independent of operating temperature typical characteristics.

# NVD260N65S3

## TYPICAL CHARACTERISTICS

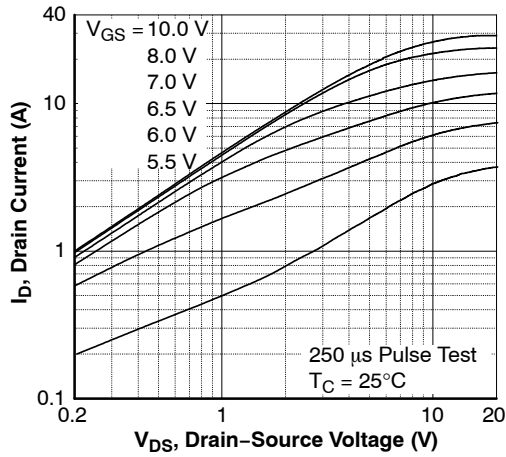


Figure 1. On-Region Characteristics 25°C

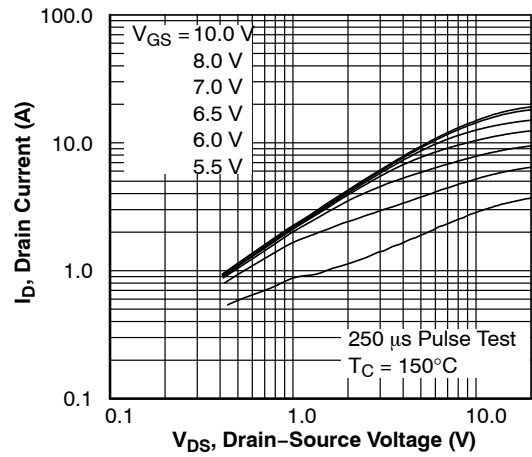


Figure 2. On-Region Characteristics 150°C

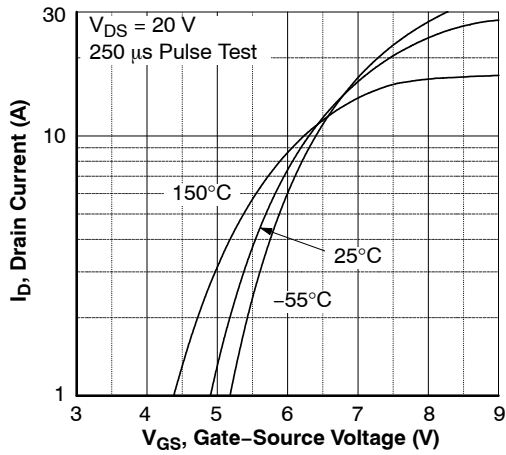


Figure 3. Transfer Characteristics

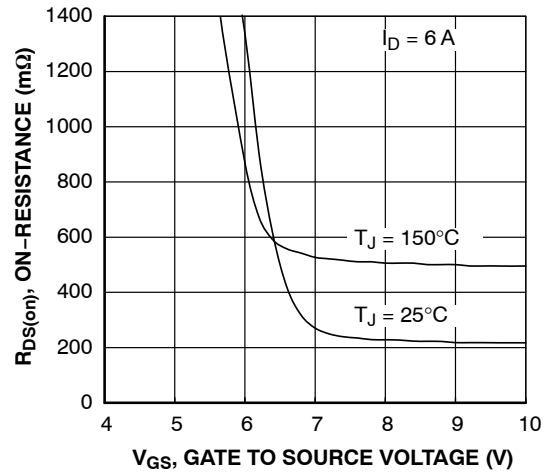


Figure 4.  $R_{DS(on)}$  vs. Gate Voltage

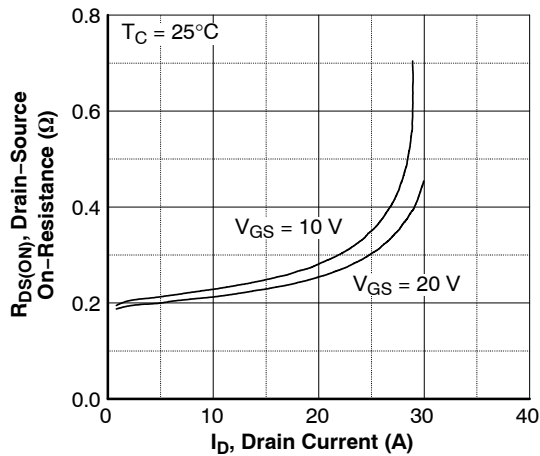


Figure 5. On-Resistance Variation vs. Drain Current and Gate Voltage

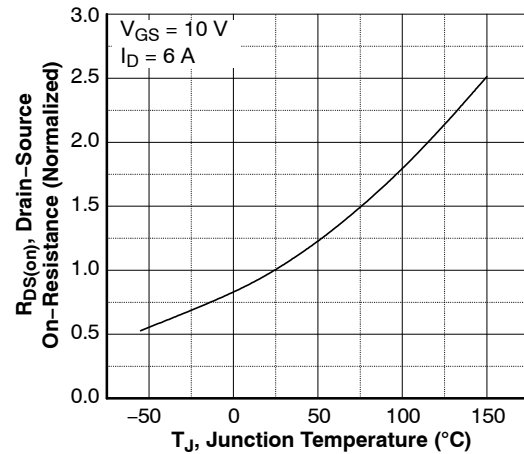


Figure 6. On-Resistance Variation vs. Temperature

TYPICAL CHARACTERISTICS

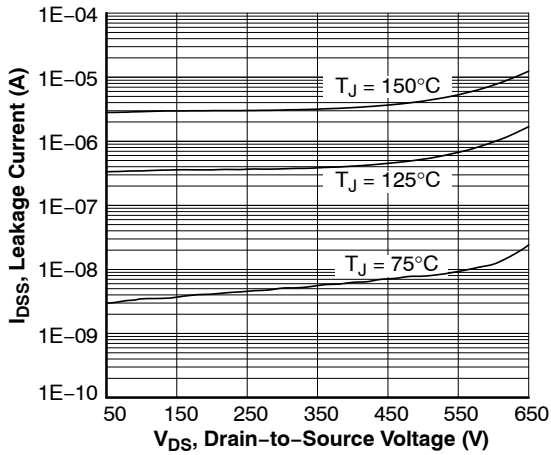


Figure 7. Drain-to-Source Leakage Current vs. Voltage

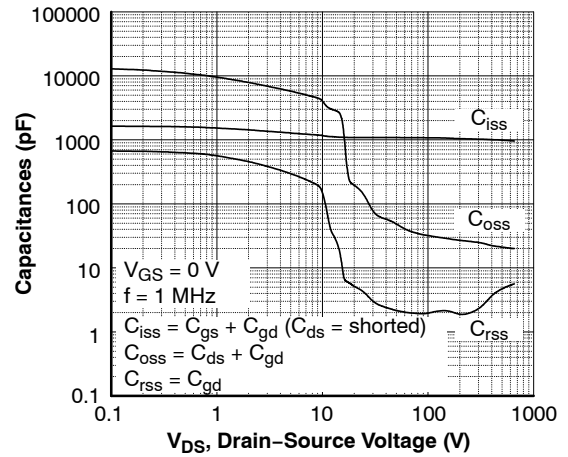


Figure 8. Capacitance Characteristics

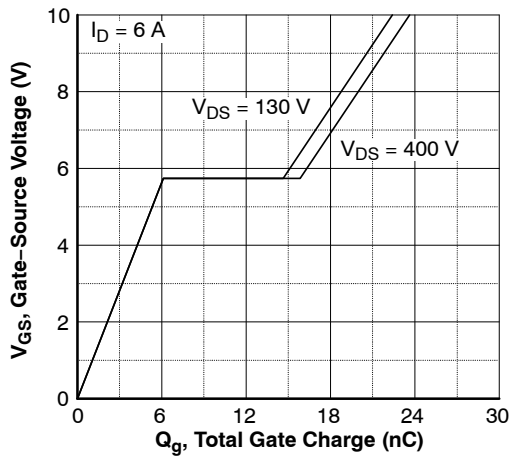


Figure 9. Gate Charge Characteristics

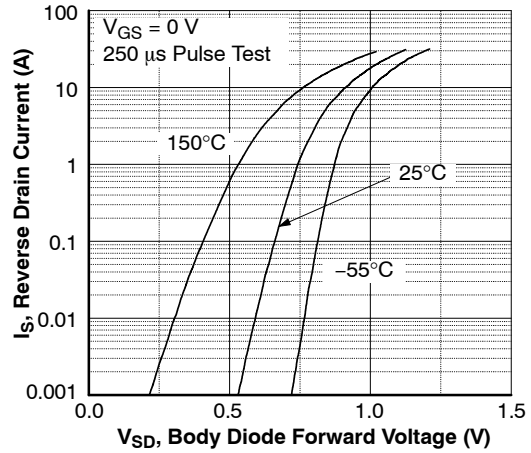


Figure 10. Body Diode Forward Voltage Variation vs. Source Current and Temperature

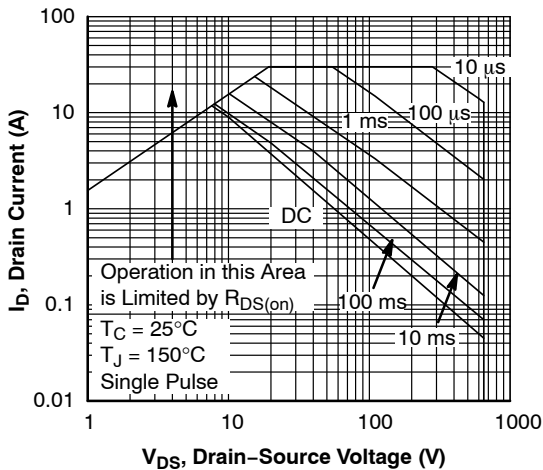


Figure 11. Maximum Safe Operating Area

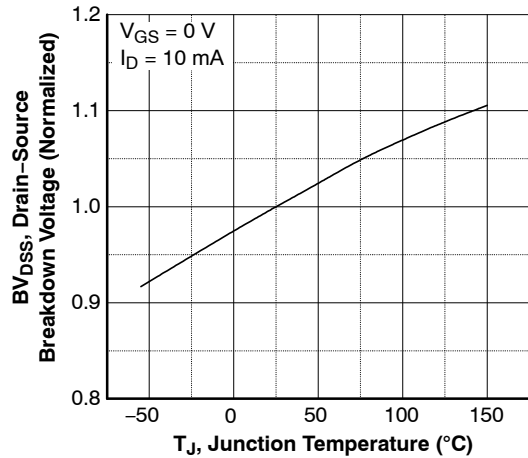


Figure 12. Breakdown Voltage Variation vs. Temperature

# NVD260N65S3

## TYPICAL CHARACTERISTICS

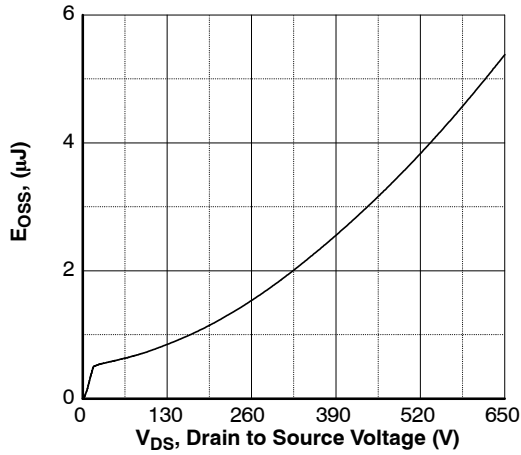


Figure 13.  $E_{OSS}$  vs. Drain to Source Voltage

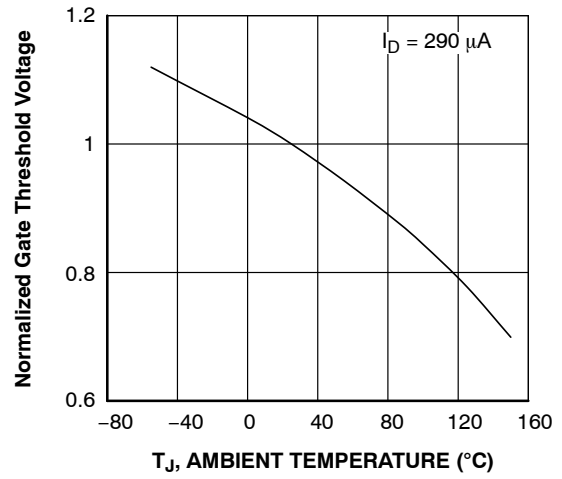


Figure 14. Normalized Gate Threshold Voltage vs. Temperature

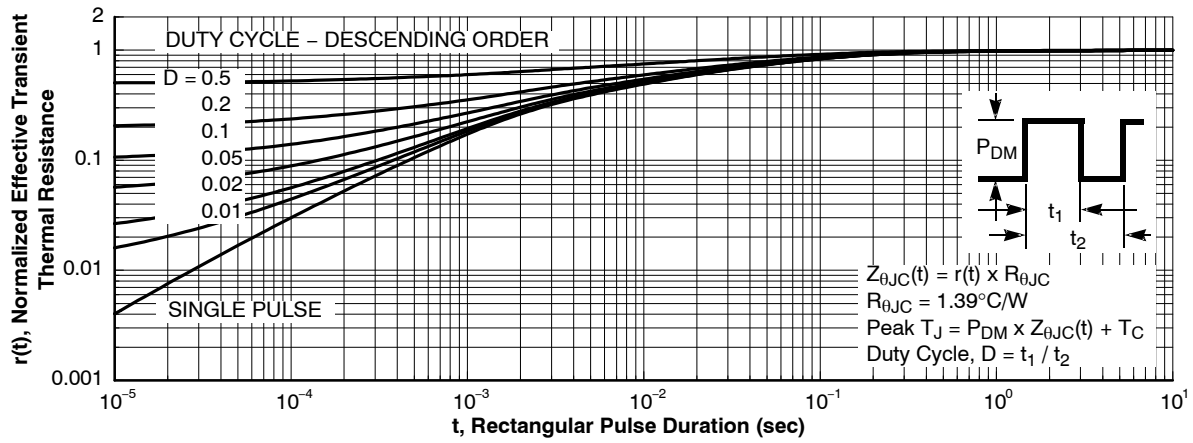


Figure 15. Transient Thermal Response Curve

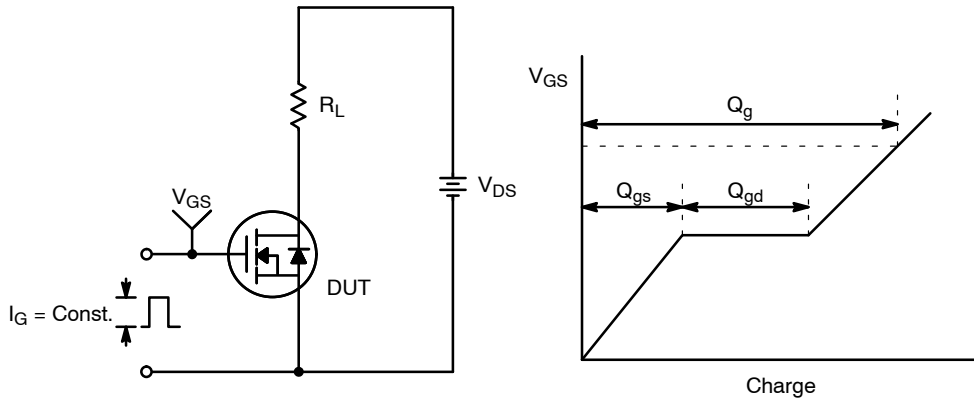


Figure 16. Gate Charge Test Circuit & Waveform

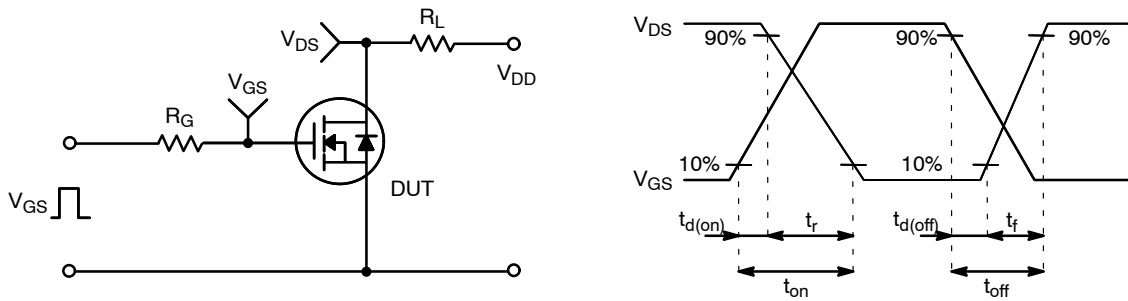


Figure 17. Resistive Switching Test Circuit & Waveforms

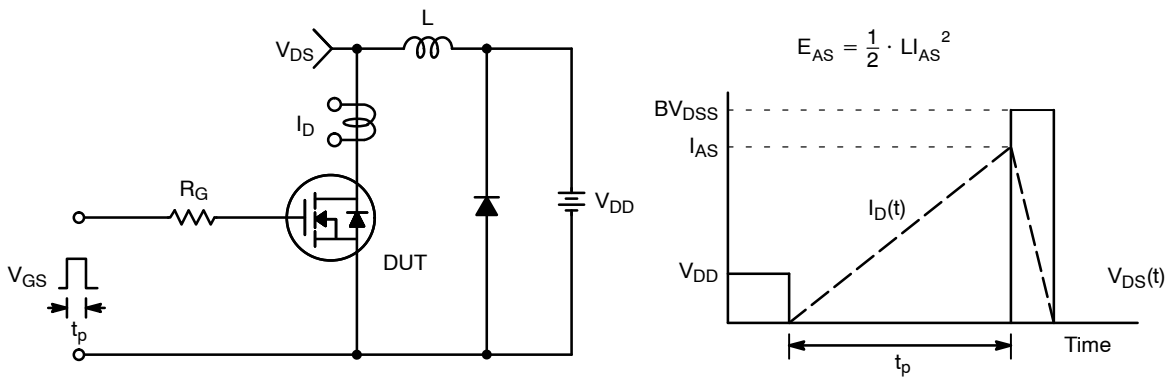
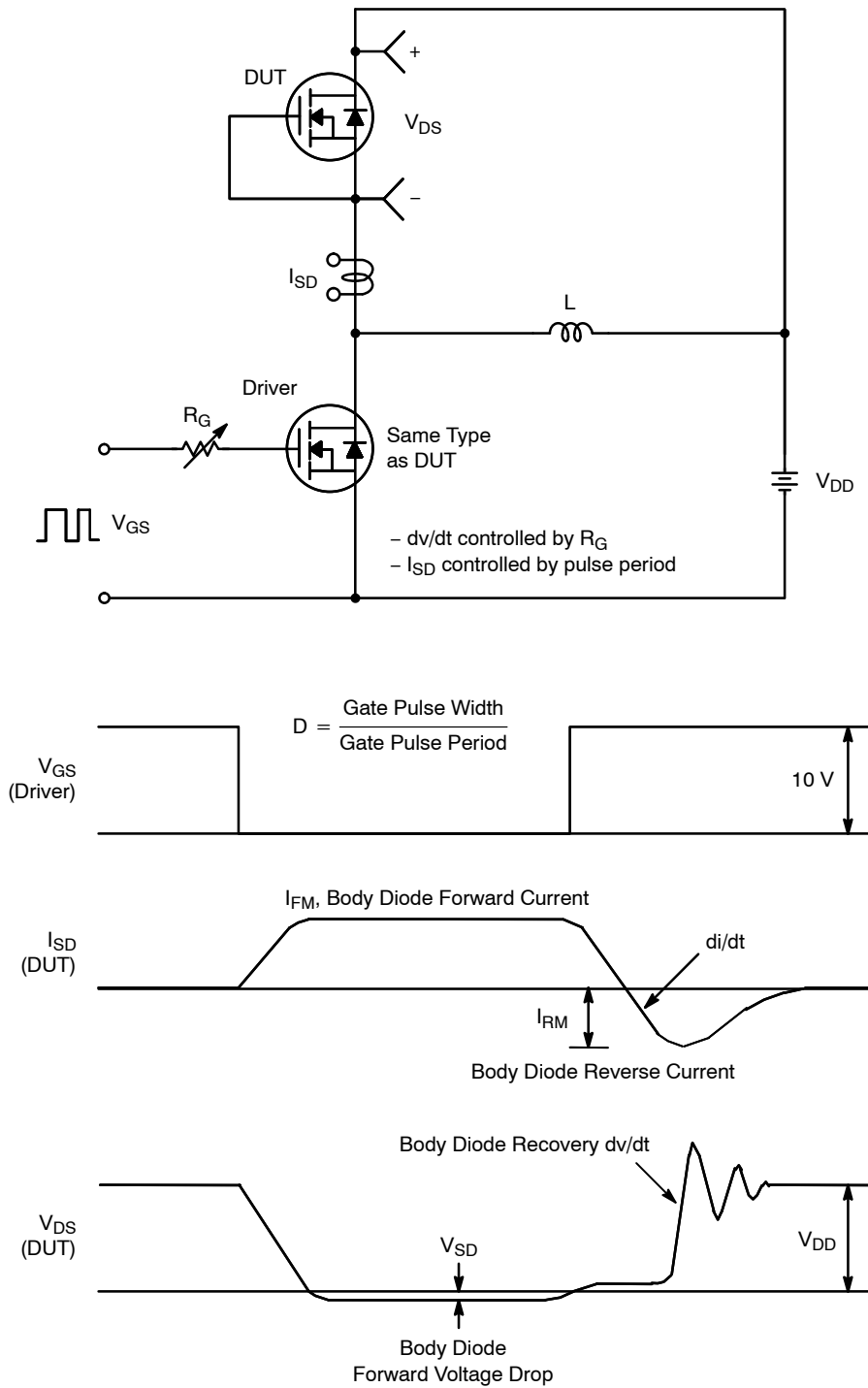


Figure 18. Unclamped Inductive Switching Test Circuit & Waveforms

# NVD260N65S3



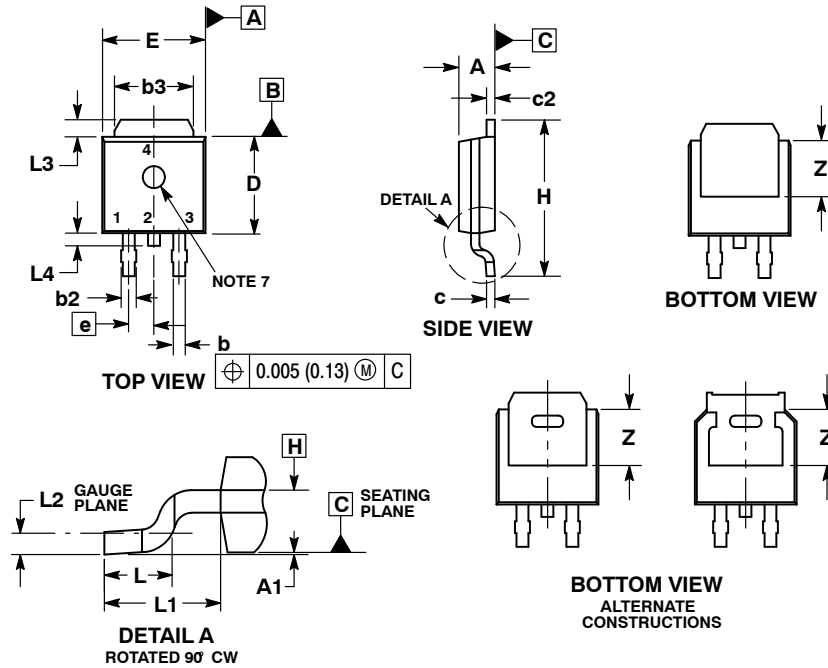
**Figure 19. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**



# NVD260N65S3

## PACKAGE DIMENSIONS

### DKPAK (SINGLE GAUGE) CASE 369C ISSUE F



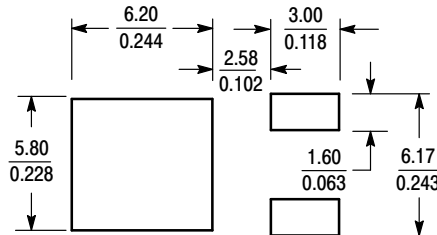
**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
5. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.
7. OPTIONAL MOLD FEATURE.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.086	0.094	2.18	2.38
A1	0.000	0.005	0.00	0.13
b	0.025	0.035	0.63	0.89
b2	0.028	0.045	0.72	1.14
b3	0.180	0.215	4.57	5.46
c	0.018	0.024	0.46	0.61
c2	0.018	0.024	0.46	0.61
D	0.235	0.245	5.97	6.22
E	0.250	0.265	6.35	6.73
e	0.090 BSC		2.29 BSC	
H	0.370	0.410	9.40	10.41
L	0.055	0.070	1.40	1.78
L1	0.114 REF		2.90 REF	
L2	0.020 BSC		0.51 BSC	
L3	0.035	0.050	0.89	1.27
L4	---	0.040	---	1.01
Z	0.155	---	3.93	---

- |  |  |   |   |  |
|--|--|---|---|--|
| <p>STYLE 1:<br/>PIN 1. BASE<br/>2. COLLECTOR<br/>3. EMITTER<br/>4. COLLECTOR</p> | <p>STYLE 2:<br/>PIN 1. GATE<br/>2. DRAIN<br/>3. SOURCE<br/>4. DRAIN</p>          | <p>STYLE 3:<br/>PIN 1. ANODE<br/>2. CATHODE<br/>3. ANODE<br/>4. CATHODE</p> | <p>STYLE 4:<br/>PIN 1. CATHODE<br/>2. ANODE<br/>3. GATE<br/>4. ANODE</p>              | <p>STYLE 5:<br/>PIN 1. GATE<br/>2. ANODE<br/>3. CATHODE<br/>4. ANODE</p>     |
| <p>STYLE 6:<br/>PIN 1. MT1<br/>2. MT2<br/>3. GATE<br/>4. MT2</p>                 | <p>STYLE 7:<br/>PIN 1. GATE<br/>2. COLLECTOR<br/>3. EMITTER<br/>4. COLLECTOR</p> | <p>STYLE 8:<br/>PIN 1. N/C<br/>2. CATHODE<br/>3. ANODE<br/>4. CATHODE</p>   | <p>STYLE 9:<br/>PIN 1. ANODE<br/>2. CATHODE<br/>3. RESISTOR ADJUST<br/>4. CATHODE</p> | <p>STYLE 10:<br/>PIN 1. CATHODE<br/>2. ANODE<br/>3. CATHODE<br/>4. ANODE</p> |


### SOLDERING FOOTPRINT\*



SCALE 3:1 (mm/inches)

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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