

# MOSFET – Power, N-Channel, SUPERFET® III, Automotive, Easy-Drive

**650 V, 65 A, 40 mΩ**

## NVHL040N65S3

### 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, provides superior switching performance, and withstand extreme dv/dt rate.

Consequently, SUPERFET III MOSFET Easy drive series helps manage EMI issues and allows for easier design implementation.

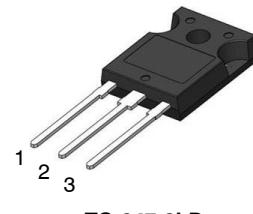
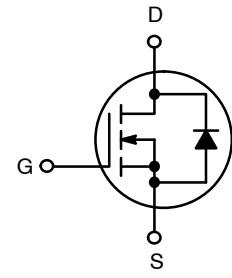
### Features

- AEC-Q101 Qualified
- 700 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 35.4 \text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 136 \text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(\text{eff.})} = 1154 \text{ pF}$ )
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

### Applications

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

$V_{DSS}$	$R_{DS(\text{ON}) \text{ MAX}}$	$I_D \text{ MAX}$
650 V	40 mΩ @ 10 V	65 A



### MARKING DIAGRAM



A	= Assembly Site
YWW	= Date Code (Year & Week)
ZZ	= Assembly Lot Number
NVHL040N65S3	= Specific Device Code

### ORDERING INFORMATION

See detailed ordering and shipping information on page 3 of this data sheet.

# NVHL040N65S3

## ABSOLUTE MAXIMUM RATINGS (T<sub>C</sub> = 25 °C, Unless otherwise noted)

Symbol	Parameter		Value	Unit
V <sub>DSS</sub>	Drain to Source Voltage		650	V
V <sub>GSS</sub>	Gate to Source Voltage	– DC	±30	V
		– AC (f > 1 Hz)	±30	
I <sub>D</sub>	Drain Current	– Continuous (T <sub>C</sub> = 25 °C)	65	A
		– Continuous (T <sub>C</sub> = 100 °C)	41	
I <sub>DM</sub>	Drain Current	– Pulsed (Note 1)	162.5	A
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)		358	mJ
I <sub>AS</sub>	Avalanche Current (Note 2)		8.1	A
E <sub>AR</sub>	Repetitive Avalanche Energy (Note 1)		4.17	mJ
dv/dt	MOSFET dv/dt		100	V/ns
	Peak Diode Recovery dv/dt (Note 3)		20	
P <sub>D</sub>	Power Dissipation	(T <sub>C</sub> = 25 °C)	417	W
		– Derate Above 25 °C	3.33	W/°C
T <sub>J</sub> , T <sub>STG</sub>	Operating and Storage Temperature Range		–55 to +150	°C
T <sub>L</sub>	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<sub>AS</sub> = 8.1 A, R<sub>G</sub> = 25 Ω, starting T<sub>J</sub> = 25 °C.
3. I<sub>SD</sub> ≤ 32.5 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> ≤ 400 V, starting T<sub>J</sub> = 25 °C.

## THERMAL CHARACTERISTICS

Symbol	Parameter	Value	Unit
R <sub>θJC</sub>	Thermal Resistance, Junction to Case, Max.	0.3	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient, Max.	40	

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

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
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### 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> = 1 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> = 1 mA, Referenced to 25 °C	–	0.64	–	V/°C
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V	–	–	1	μA
		V <sub>DS</sub> = 520 V, T <sub>C</sub> = 125 °C	–	4.5	–	
I <sub>GSS</sub>	Gate to Body Leakage Current	V <sub>GS</sub> = ±30 V, V <sub>DS</sub> = 0 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> = 1.7 mA	2.5	–	4.5	V
R <sub>D5(on)</sub>	Static Drain to Source On Resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 32.5 A	–	35.4	40	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 32.5 A	–	46	–	S

# NVHL040N65S3

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

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

$C_{iss}$	Input Capacitance	$V_{DS} = 400\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$	–	4740	–	pF
$C_{oss}$	Output Capacitance		–	120	–	pF
$C_{oss(\text{eff.})}$	Effective Output Capacitance	$V_{DS} = 0\text{ V}$ to $400\text{ V}$ , $V_{GS} = 0\text{ V}$	–	1154	–	pF
$C_{oss(\text{er.})}$	Energy Related Output Capacitance	$V_{DS} = 0\text{ V}$ to $400\text{ V}$ , $V_{GS} = 0\text{ V}$	–	171	–	pF
$Q_{g(\text{tot})}$	Total Gate Charge at 10 V	$V_{DS} = 400\text{ V}$ , $I_D = 32.5\text{ A}$ , $V_{GS} = 10\text{ V}$ (Note 4)	–	136	–	nC
$Q_{gs}$	Gate to Source Gate Charge		–	33	–	nC
$Q_{gd}$	Gate to Drain "Miller" Charge		–	59	–	nC
ESR	Equivalent Series Resistance	$f = 1\text{ MHz}$	–	0.7	–	$\Omega$

## SWITCHING CHARACTERISTICS

$t_{d(\text{on})}$	Turn-On Delay Time	$V_{DD} = 400\text{ V}$ , $I_D = 32.5\text{ A}$ , $V_{GS} = 10\text{ V}$ , $R_g = 3.3\Omega$ (Note 4)	–	35	–	ns
$t_r$	Turn-On Rise Time		–	51	–	ns
$t_{d(\text{off})}$	Turn-Off Delay Time		–	95	–	ns
$t_f$	Turn-Off Fall Time		–	30	–	ns

## SOURCE-DRAIN DIODE CHARACTERISTICS

$I_S$	Maximum Continuous Drain to Source Diode Forward Current	–	–	65	A	
$I_{SM}$	Maximum Pulsed Drain to Source Diode Forward Current	–	–	162.5	A	
$V_{SD}$	Drain to Source Diode Forward Voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 32.5\text{ A}$	–	–	1.2	V
$t_{rr}$	Reverse Recovery Time	$V_{GS} = 0\text{ V}$ , $I_{SD} = 32.5\text{ A}$ , $dI_F/dt = 100\text{ A}/\mu\text{s}$	–	534	–	ns
$Q_{rr}$	Reverse Recovery Charge		–	13.6	–	$\mu\text{C}$

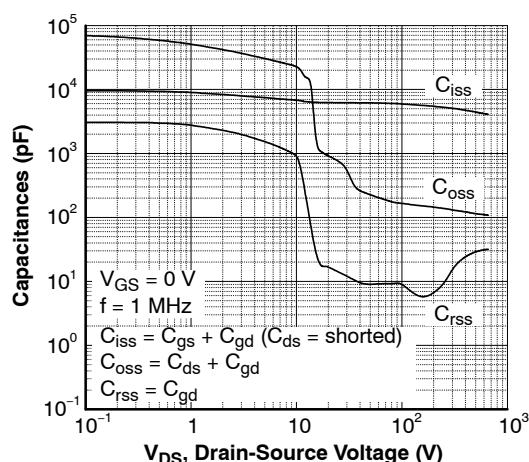
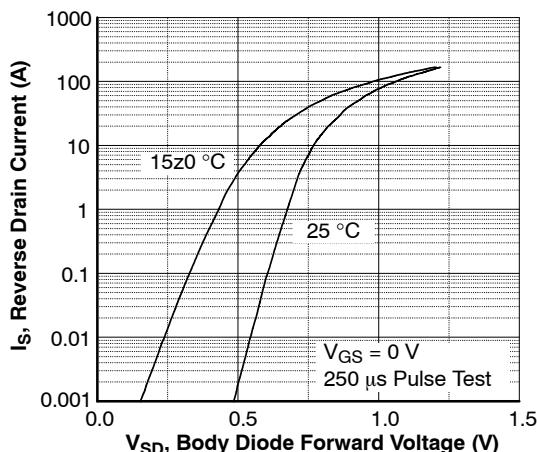
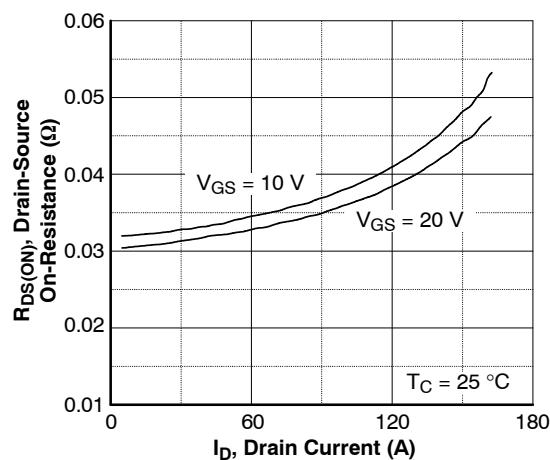
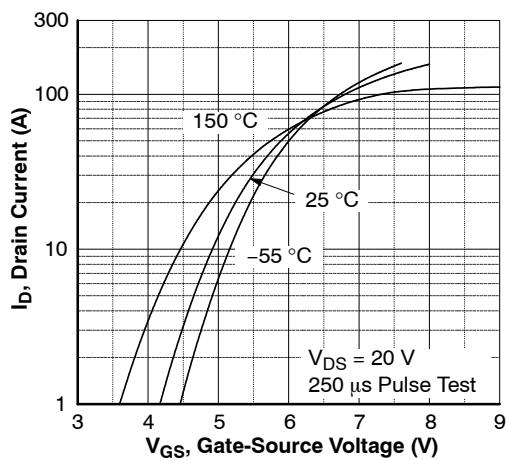
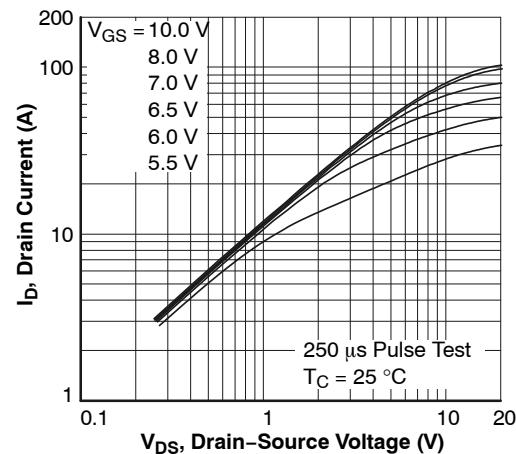
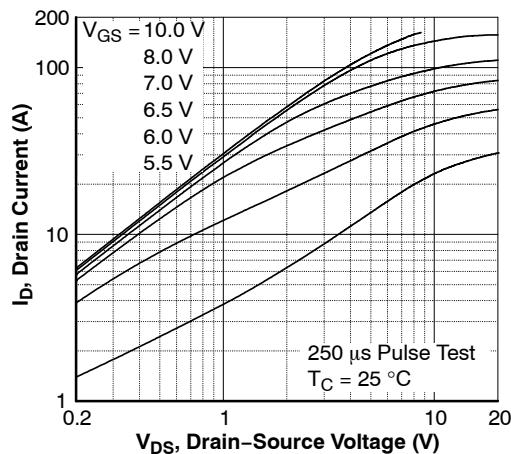
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

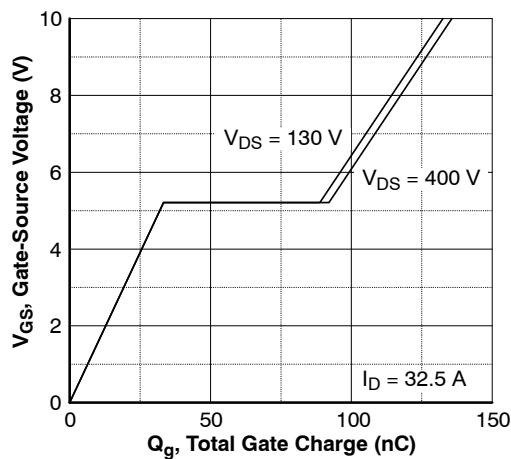
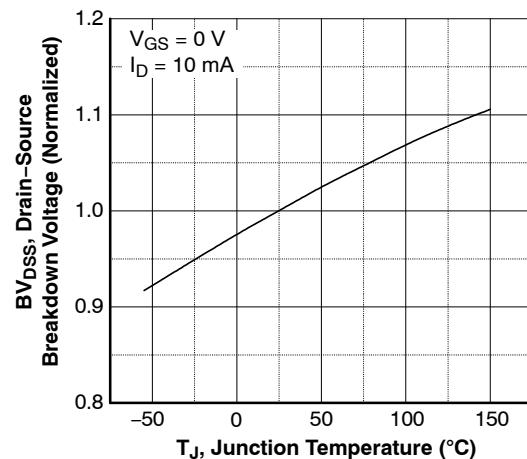
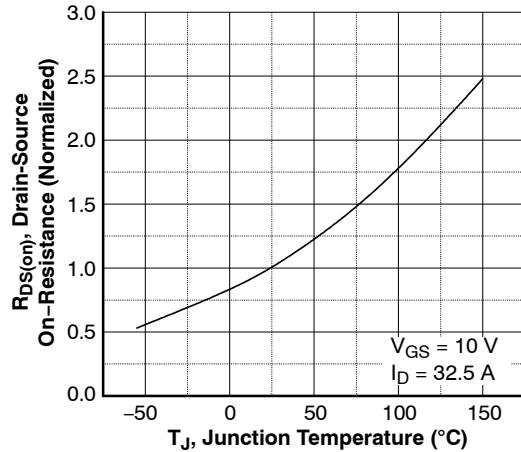
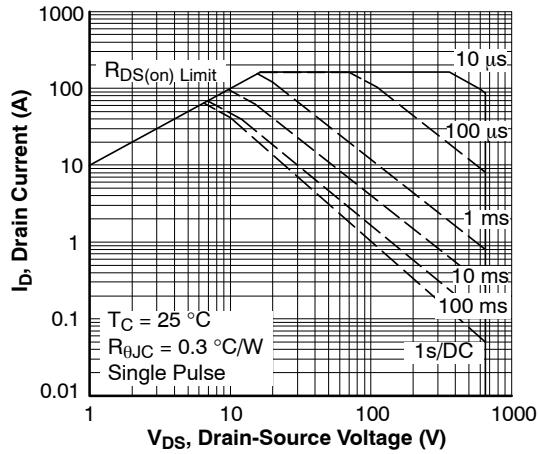
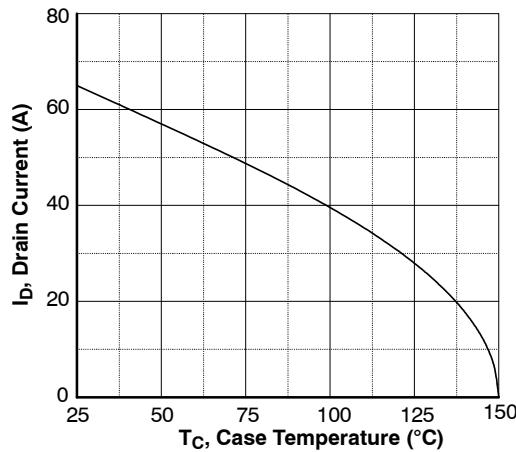
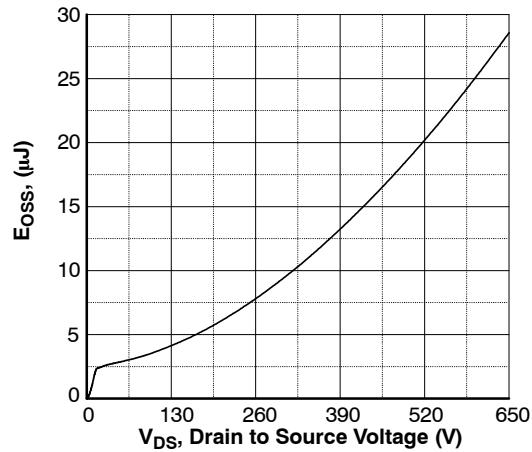
4. Essentially independent of operating temperature typical characteristics.

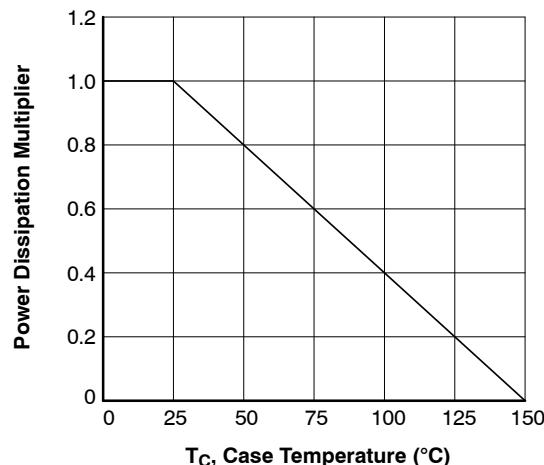
## PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Top Marking	Package	Packing Method	Reel Size	Tape Width	Quantity
NVHL040N65S3	NVHL040N65S3	TO-247 G03	Tube	N/A	N/A	30 Units

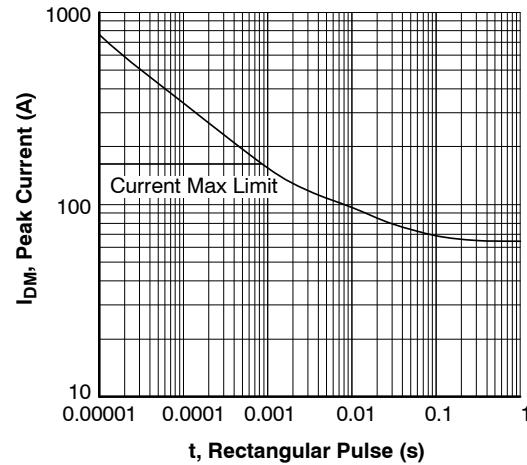
## TYPICAL PERFORMANCE CHARACTERISTICS



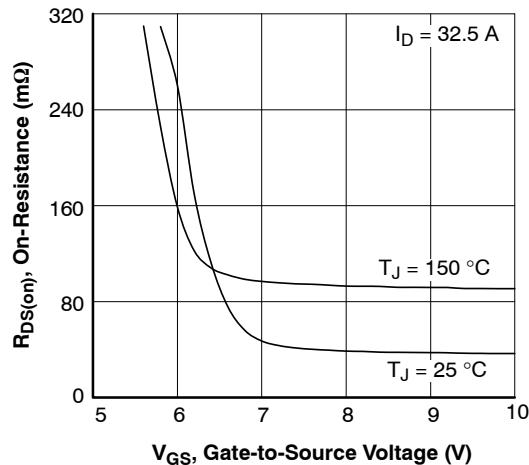
**TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)**

**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 PERFORMANCE CHARACTERISTICS (CONTINUED)**


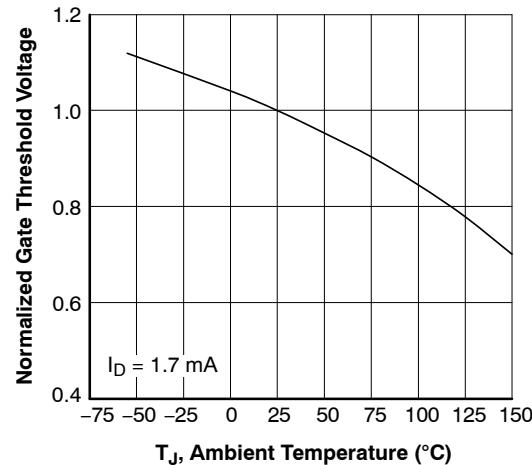
**Figure 13. Normalized Power Dissipation vs. Case Temperature**



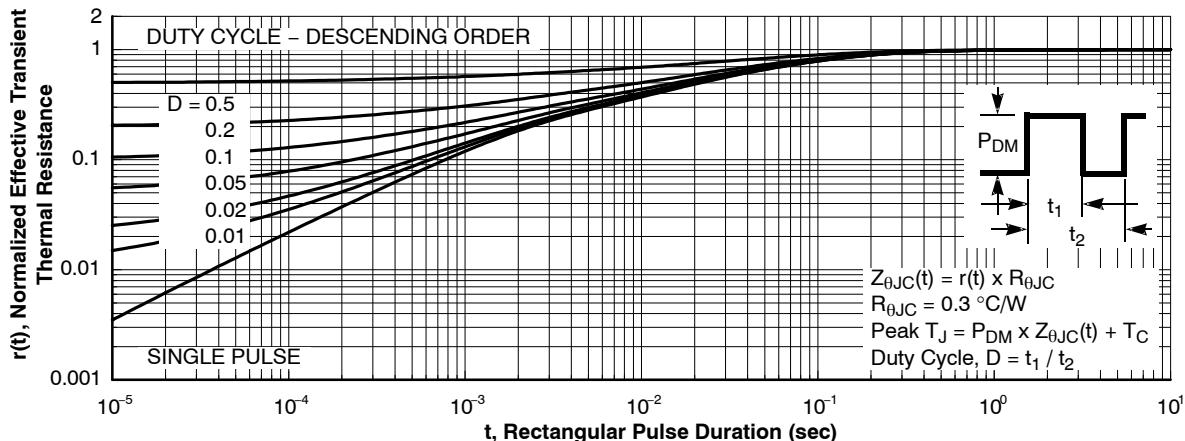
**Figure 14. Peak Current Capability**



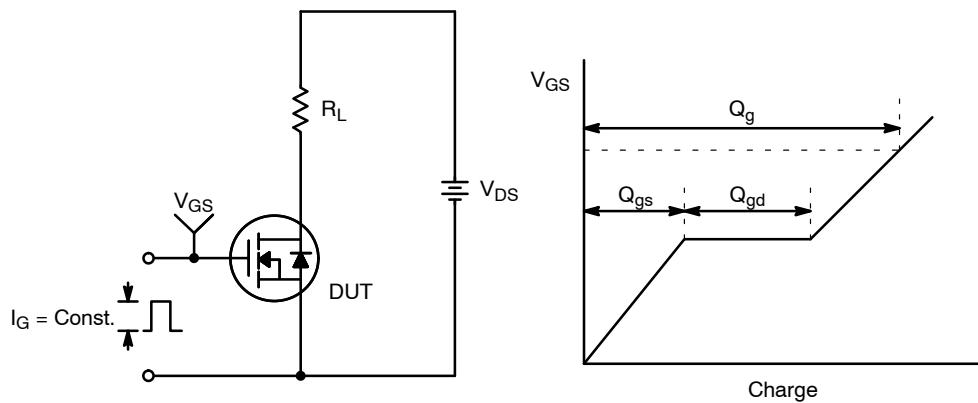
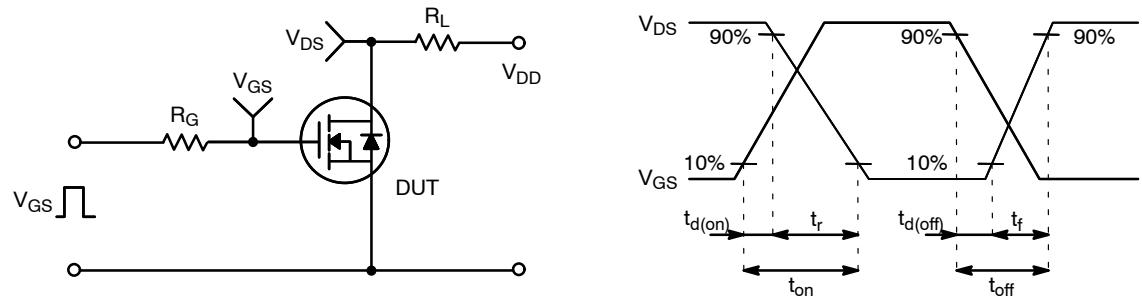
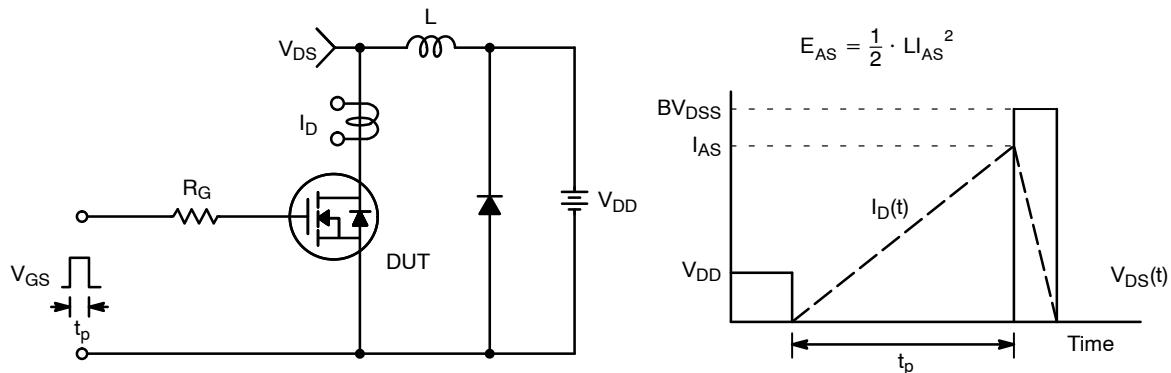
**Figure 15. R<sub>DS(on)</sub> vs. Gate Voltage Figure**



**Figure 16. Normalized Gate Threshold Voltage vs. Temperature**



**Figure 17. Transient Thermal Response Curve**


**Figure 18. Gate Charge Test Circuit & Waveform**

**Figure 19. Resistive Switching Test Circuit & Waveforms**

**Figure 20. Unclamped Inductive Switching Test Circuit & Waveforms**

## NVHL040N65S3

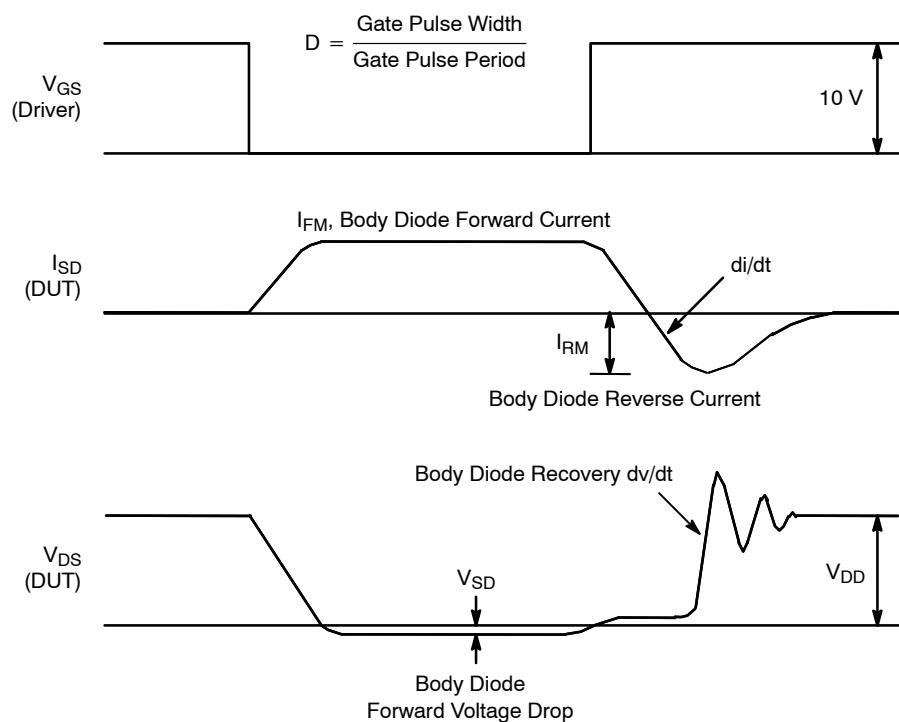
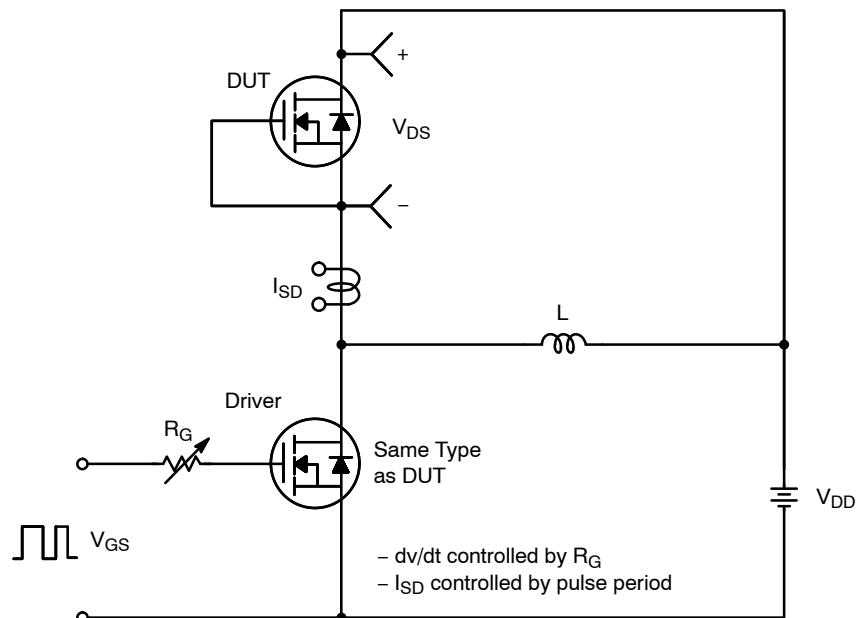
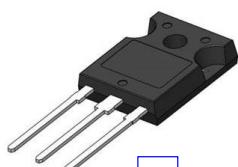


Figure 21. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms

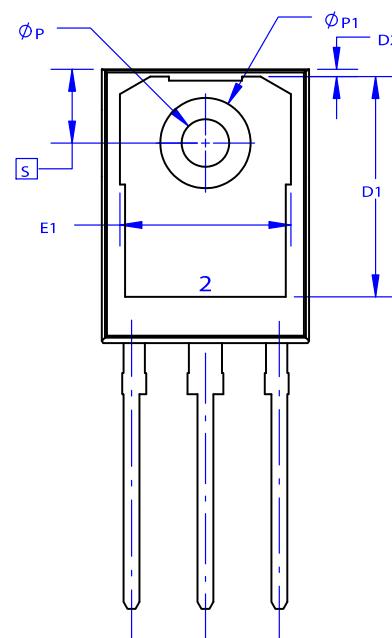
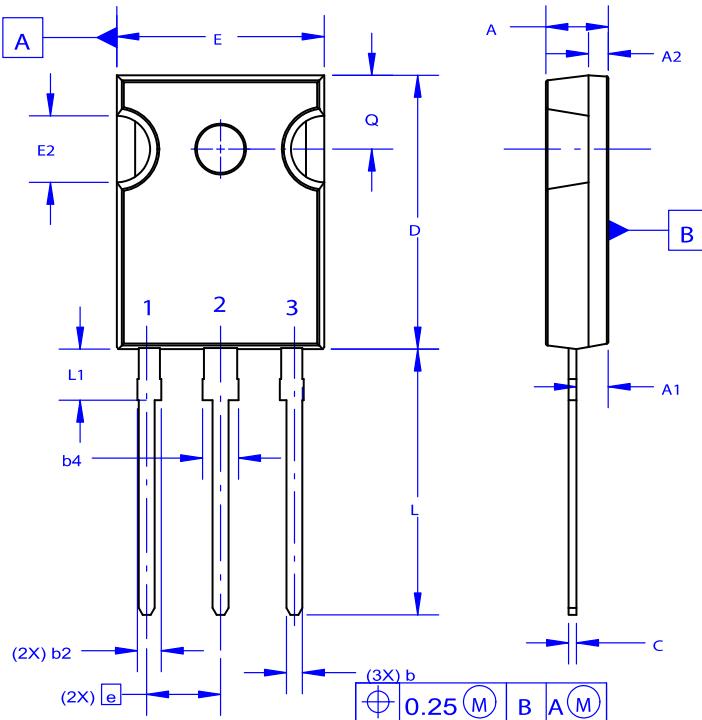
**REVISION HISTORY**

Revision	Description of Changes	Date
1	Rebranded the Data Sheet to <b>onsemi</b> format.	10/15/2025

This document has undergone updates prior to the inclusion of this revision history table. The changes tracked here only reflect updates made on the noted approval dates.

TO-247-3LD  
CASE 340CX  
ISSUE A

DATE 06 JUL 2020



## 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	2.20	2.40	2.60
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	6.60	6.80	7.00

GENERIC  
MARKING DIAGRAM\*

XXXXX = 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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