

# NVHL110N65S3F

## **MOSFET** – Power, **N-Channel, SUPERFET® III,** **FRFET®,**

**650 V, 30 A, 110 mΩ**

### 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.  $R_{DS(on)} = 93\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 58\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 553\text{ pF}$ )
- 100% Avalanche Tested
- AEC-Q101 Qualified and PPAP Capable

### Applications

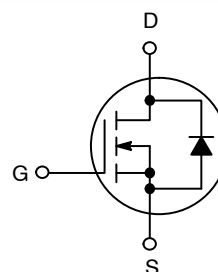
- Automotive On Board Charger HEV-EV
- Automotive DC/DC converter for HEV-EV



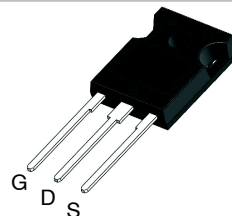
**ON Semiconductor®**

[www.onsemi.com](http://www.onsemi.com)

$V_{DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
650 V	110 mΩ @ 10 V	30 A



**N-Channel MOSFET**



**TO-247 LONG LEADS  
CASE 340CX**

### MARKING DIAGRAM



\$Y	= ON Semiconductor Logo
&Z	= Assembly Plant Code
&3	= Numeric Date Code
&K	= Lot Code
NVHL110N65S3F	= Specific Device Code

### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

# NVHL110N65S3F

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

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	V
I <sub>D</sub>	Drain Current	Continuous (T <sub>C</sub> = 25°C)	30	A
		Continuous (T <sub>C</sub> = 100°C)	19.5	
I <sub>DM</sub>	Drain Current	Pulsed (Note 1)	69	A
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)		380	mJ
E <sub>AR</sub>	Repetitive Avalanche Energy (Note 1)		2.4	mJ
dv/dt	MOSFET dv/dt		100	V/ns
	Peak Diode Recovery dv/dt (Note 3)		50	
P <sub>D</sub>	Power Dissipation	(T <sub>C</sub> = 25°C)	240	W
		Derate Above 25°C	1.92	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 s		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> = 3.5 A, R<sub>G</sub> = 25 Ω, starting T<sub>J</sub> = 25°C.

3. I<sub>SD</sub> ≤ 15 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.	0.52	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient, Max.	40	

## PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Top Marking	Package	Packing Method	Reel Size	Tape Width	Quantity
NVHL110N65S3F	NVHL110N65S3F	TO-247	Tube	N/A	N/A	30 Units

# NVHL110N65S3F

## 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> = 10 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> = 20 mA, Referenced to 25°C	–	0.61	–	V/°C
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V	–	–	10	μA
		V <sub>DS</sub> = 520 V, T <sub>C</sub> = 125°C	–	44	–	
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> = 3 mA	3.0	–	5.0	V
R <sub>DS(on)</sub>	Static Drain to Source On Resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 15 A	–	93	110	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 15 A	–	17	–	S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	2560	–	pF
C <sub>oss</sub>	Output Capacitance		–	50	–	pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V	–	553	–	pF
C <sub>oss(er.)</sub>	Energy Related Output Capacitance	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V	–	83	–	pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	V <sub>DS</sub> = 400 V, I <sub>D</sub> = 15 A, V <sub>GS</sub> = 10 V (Note 4)	–	58	–	nC
Q <sub>gs</sub>	Gate to Source Gate Charge		–	19	–	nC
Q <sub>gd</sub>	Gate to Drain “Miller” Charge		–	23	–	nC
ESR	Equivalent Series Resistance	f = 1 MHz	–	2	–	Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 400 V, I <sub>D</sub> = 15 A, V <sub>GS</sub> = 10 V, R <sub>g</sub> = 4.7 Ω (Note 4)	–	29	–	ns
t <sub>r</sub>	Turn-On Rise Time		–	32	–	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		–	61	–	ns
t <sub>f</sub>	Turn-Off Fall Time		–	16	–	ns

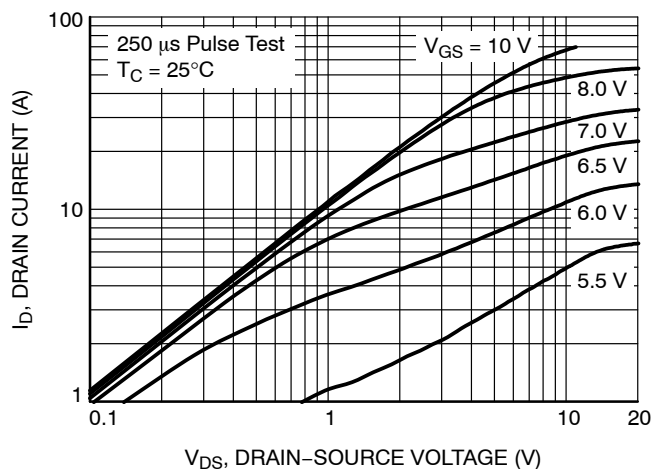
### SOURCE-DRAIN DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Source to Drain Diode Forward Current		–	–	30	A
I <sub>SM</sub>	Maximum Pulsed Source to Drain Diode Forward Current		–	–	69	A
V <sub>SD</sub>	Source to Drain Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 15 A	–	–	1.3	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 15 A, dI <sub>F</sub> /dt = 100 A/μs	–	94	–	ns
Q <sub>rr</sub>	Reverse Recovery Charge		–	343	–	nC

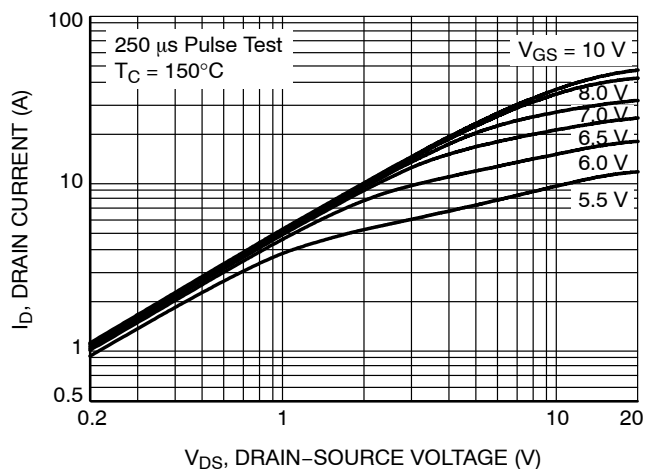
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. Essentially independent of operating temperature typical characteristics.

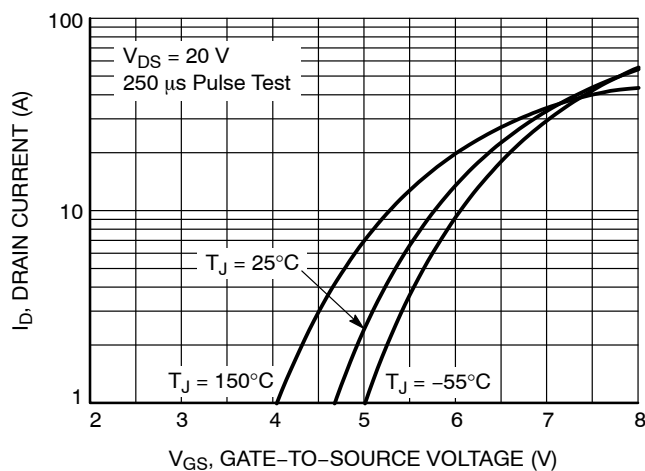
# TYPICAL CHARACTERISTICS



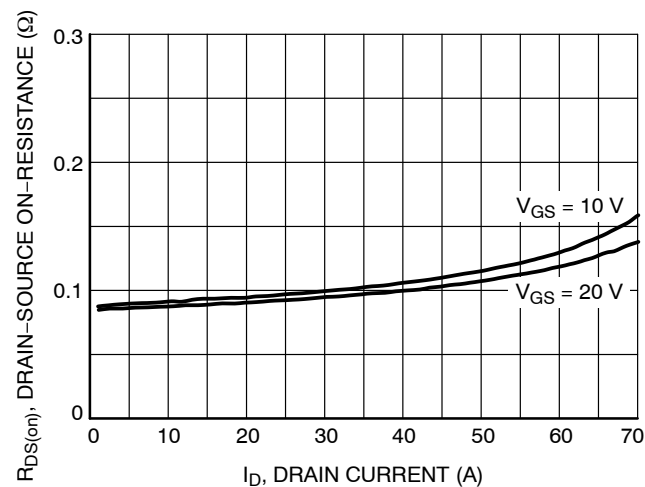
**Figure 1. On-Region Characteristics  
25°C**



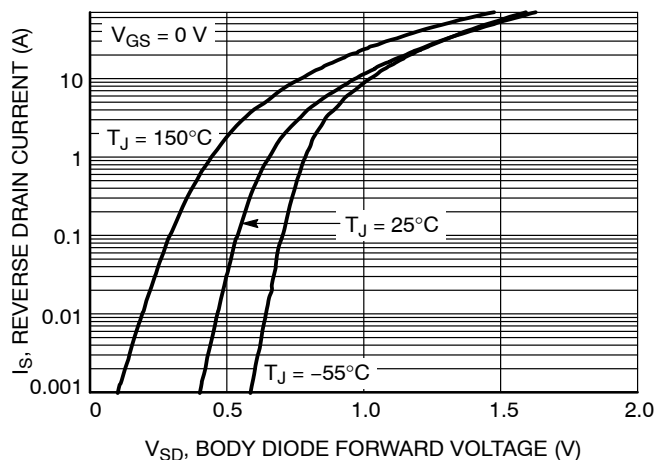
**Figure 2. On-Region Characteristics  
150°C**



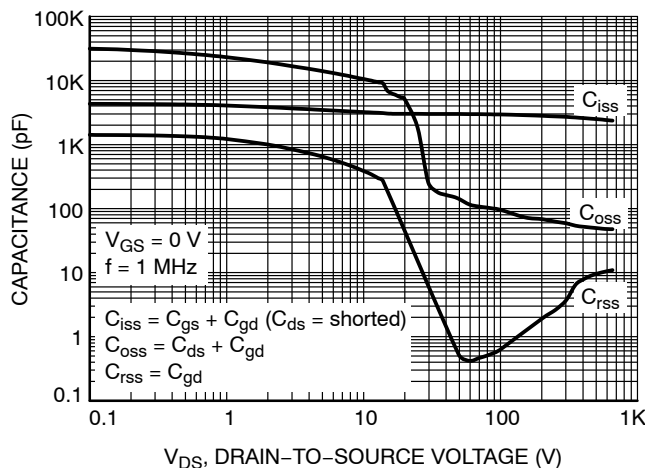
**Figure 3. Transfer Characteristics**



**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

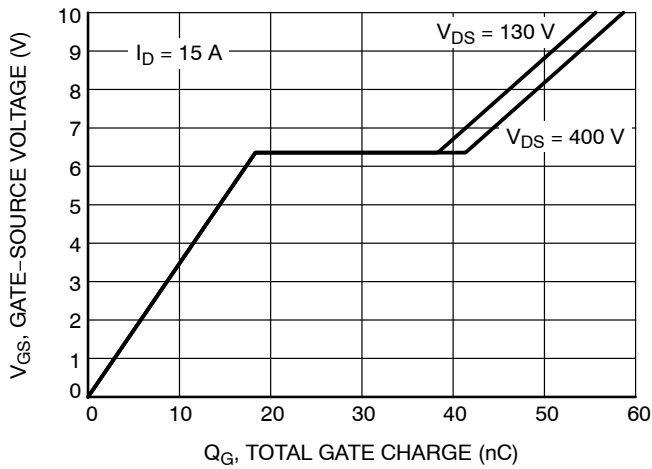


Figure 7. Gate Charge Characteristics

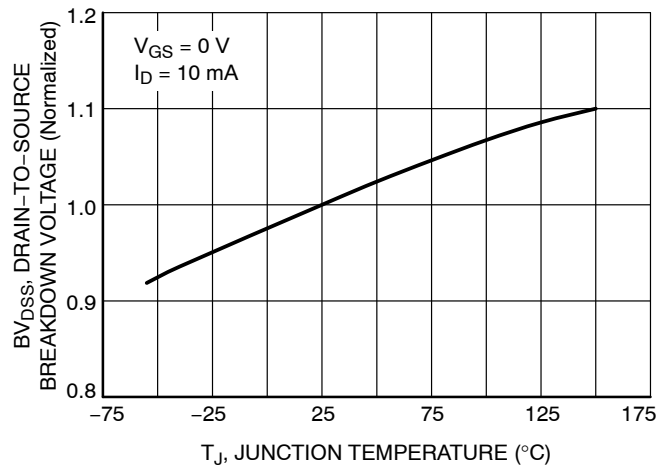


Figure 8. Breakdown Voltage Variation vs. Temperature

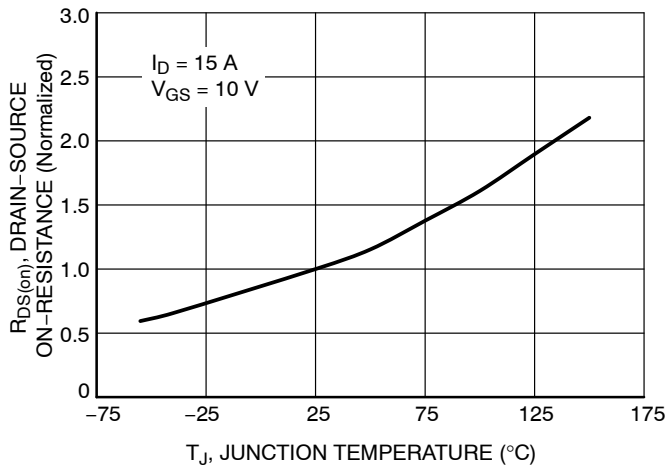


Figure 9. On-Resistance Variation vs. Temperature

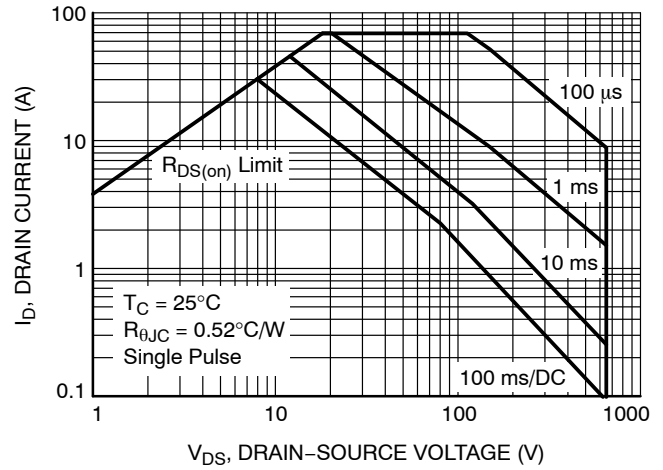


Figure 10. Maximum Safe Operating Area

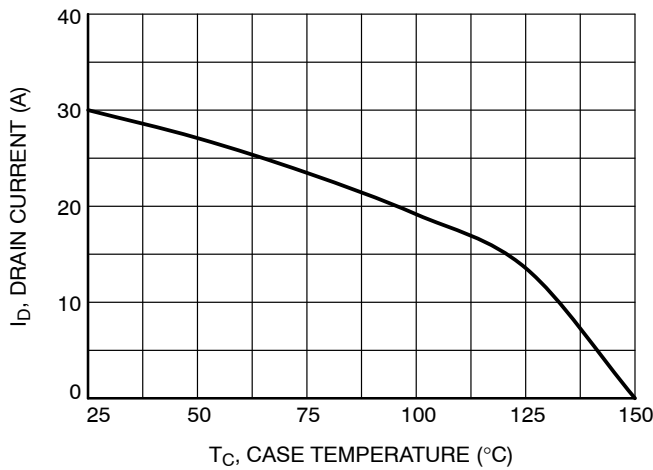


Figure 11. Maximum Drain Current vs. Case Temperature

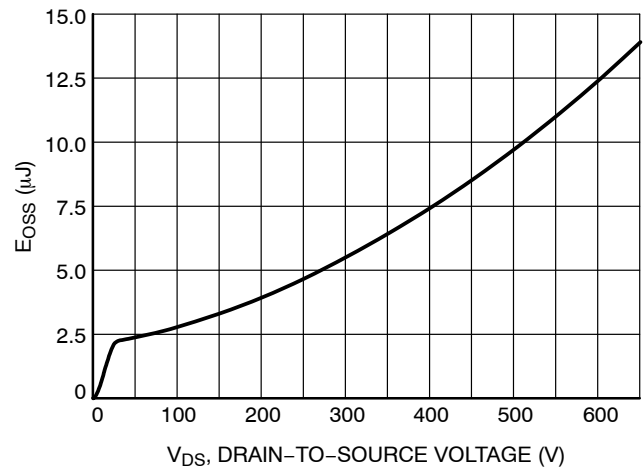


Figure 12.  $E_{OSS}$  vs. Drain-to-Source Voltage

TYPICAL CHARACTERISTICS

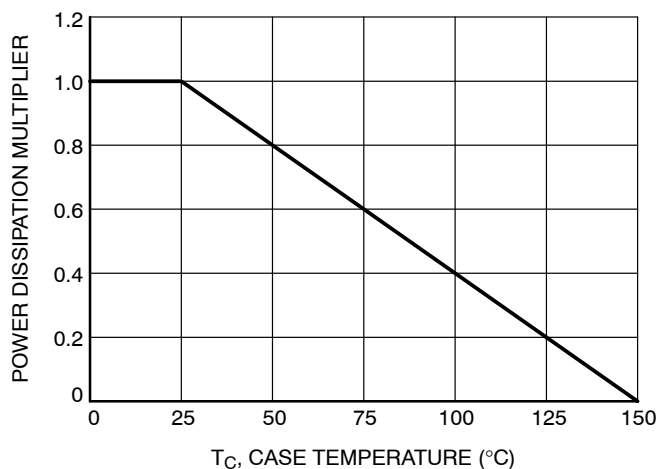


Figure 13. Normalized Power Dissipation vs. Case Temperature

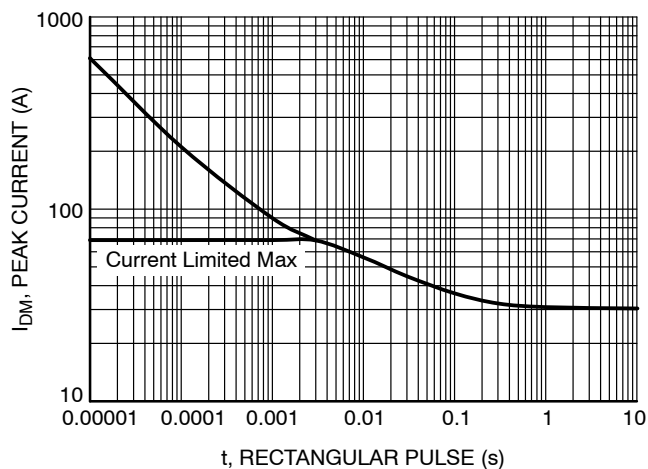


Figure 14. Peak Current Capability

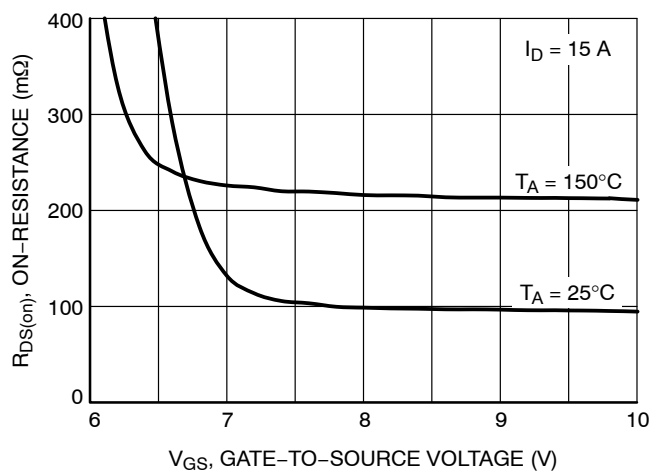


Figure 15.  $R_{DS(on)}$  vs. Gate Voltage

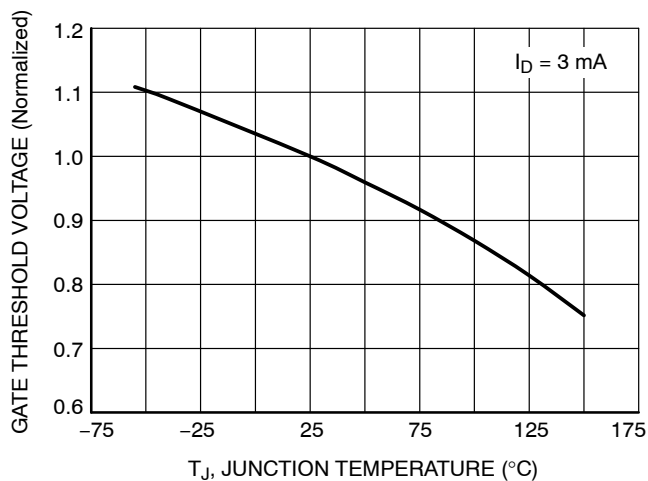
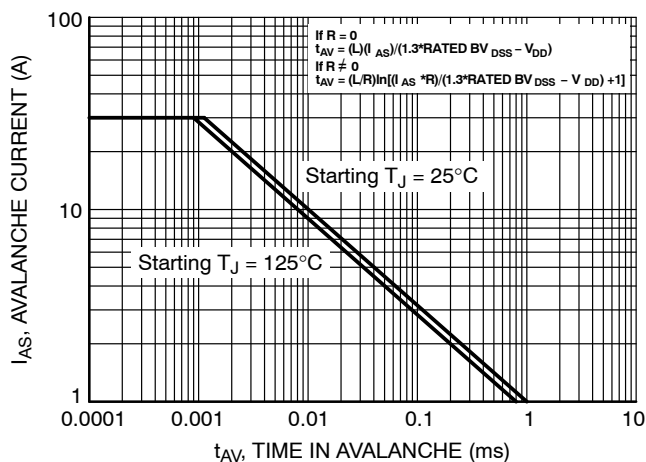


Figure 16. Normalized Gate Threshold Voltage vs. Temperature



NOTE: Refer to Application Notes AN7514 and AN7515

Figure 17. Unclamped Inductive Switching Capability

TYPICAL CHARACTERISTICS

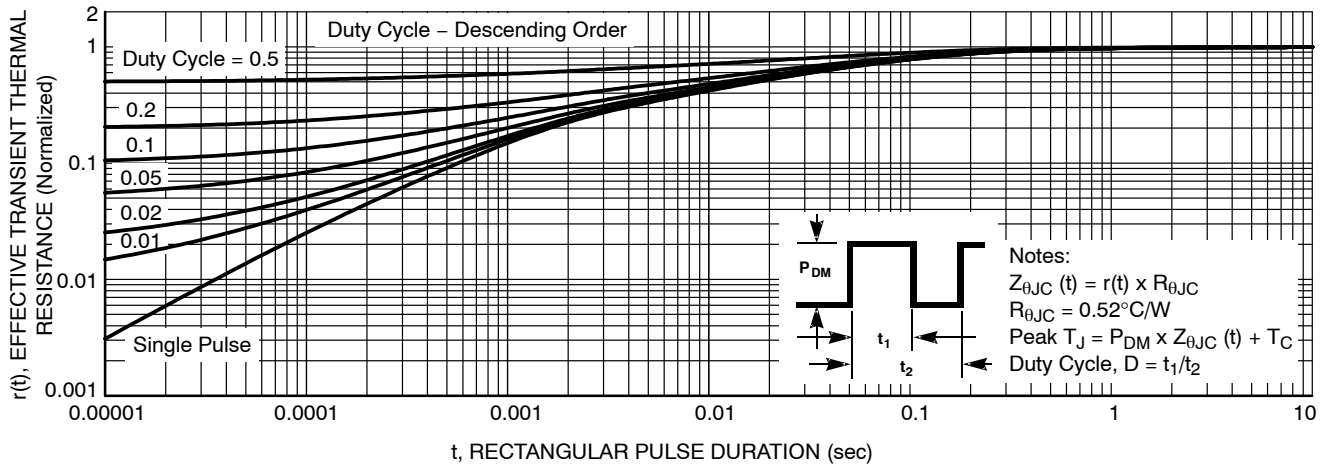


Figure 18. Transient Thermal Response

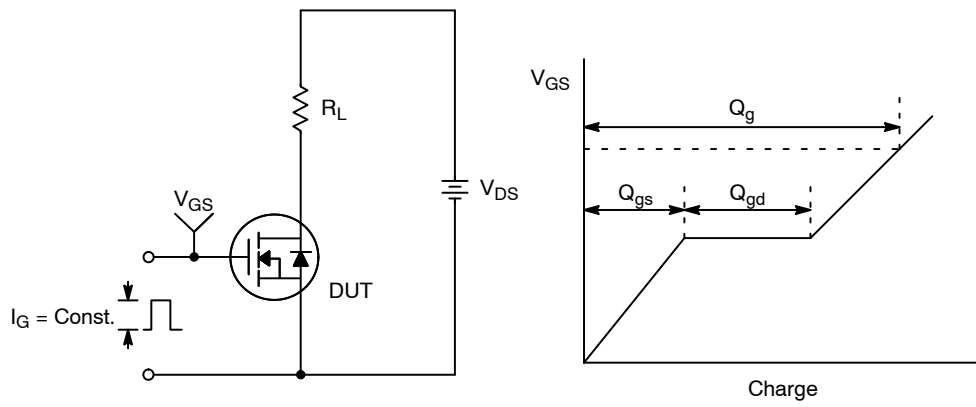


Figure 19. Gate Charge Test Circuit & Waveform

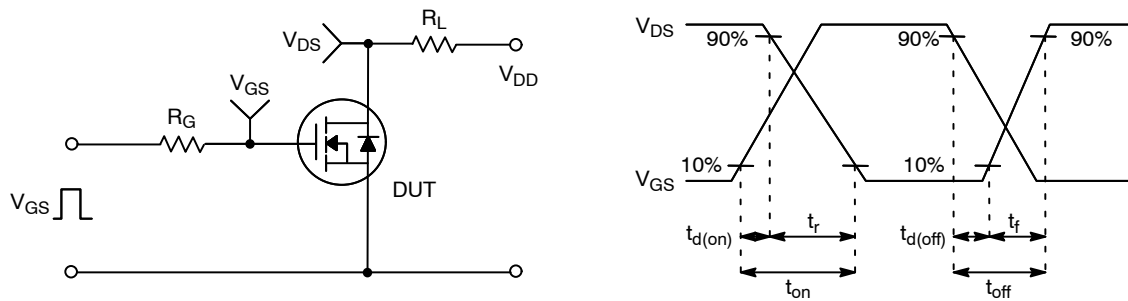


Figure 20. Resistive Switching Test Circuit & Waveforms

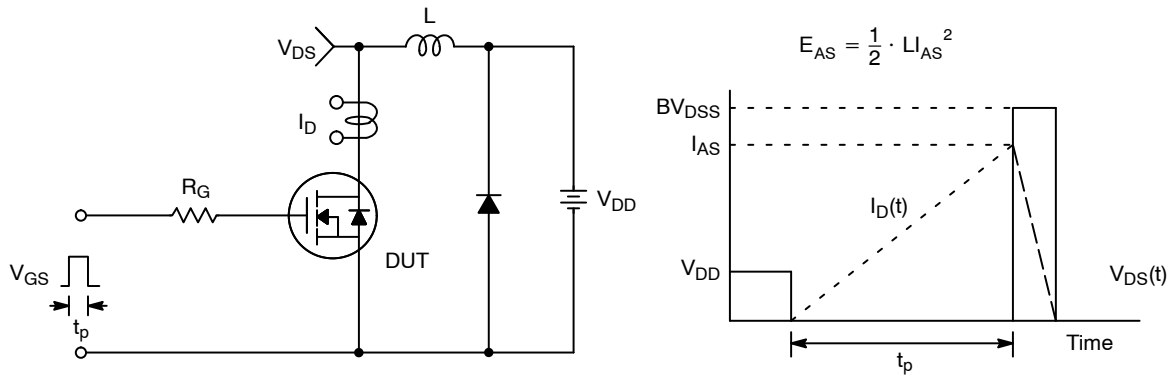


Figure 21. Unclamped Inductive Switching Test Circuit & Waveforms



The diagram shows a switching circuit. A MOSFET labeled "Driver" and "Same Type as DUT" is driven by a gate voltage  $V_{GS}$  through a gate resistor  $R_G$ . The driver's drain is connected to the source of the DUT. The DUT's drain is connected to a load inductor  $L$  and a positive supply  $V_{DD}$ . The DUT's source is connected to a negative supply  $V_{SD}$  through a sense resistor. The current through the sense resistor is labeled  $I_{SD}$ . The DUT is represented by a circle with a diode symbol and the label "DUT".

Key components and labels:

- $V_{GS}$ : Gate voltage pulse input.
- $R_G$ : Gate resistor.
- Driver**: MOSFET driving the DUT.
- DUT**: Diode Under Test.
- $V_{SD}$ : Source-drain voltage of the DUT.
- $I_{SD}$ : Source-drain current of the DUT.
- $L$ : Load inductor.
- $V_{DD}$ : Positive supply voltage.

Notes:

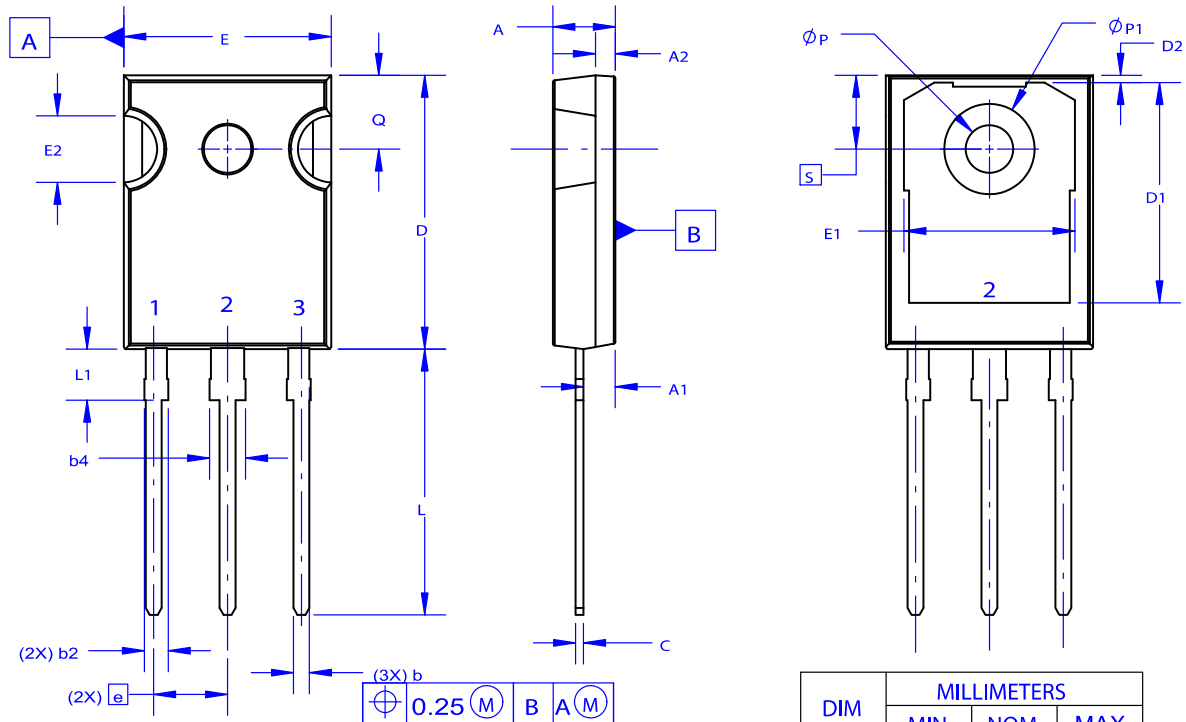
- $- dv/dt$  controlled by  $R_G$
- $- I_{SD}$  controlled by pulse period



# NVHL110N65S3F

## PACKAGE DIMENSIONS


TO-247-3LD  
CASE 340CX  
ISSUE O



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.

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