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

**650 V, 50 mΩ, 58 A**

## NVHL050N65S3F

### 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.  $R_{DS(on)} = 42\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 121\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 1119\text{ pF}$ )
- 100% Avalanche Tested
- AEC–Q101 Qualified and PPAP Capable
- These Devices are Pb–Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

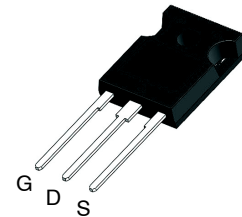
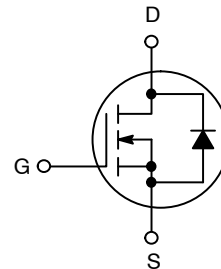
- Automotive On Board Charger HEV–EV
- Automotive DC/DC Converter HEV–EV



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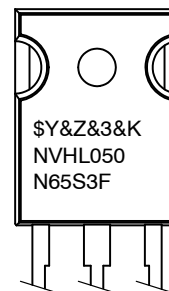
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$V_{DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
650 V	50 mΩ	58 A



TO–247 long leads  
CASE 340CX

### MARKING DIAGRAM



\$Y = ON Semiconductor Logo  
 &Z = Assembly Plant Code  
 &3 = Date Code (Year & Week)  
 &K = Lot  
 NVHL050N65S3F = Specific Device Code

### ORDERING INFORMATION

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

# NVHL050N65S3F

## 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
		- AC (f > 1 Hz)	±30
I <sub>D</sub>	Drain Current	- Continuous (T <sub>C</sub> = 25°C)	58
		- Continuous (T <sub>C</sub> = 100°C)	36
I <sub>DM</sub>	Drain Current	- Pulsed (Note 1)	145
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)	830	mJ
I <sub>AS</sub>	Avalanche Current (Note 2)	7.5	A
E <sub>AR</sub>	Repetitive Avalanche Energy (Note 1)	4.03	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)	403
		- Derate Above 25°C	3.23
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> = 7.5 A, R<sub>G</sub> = 25 Ω, starting T<sub>J</sub> = 25°C.
3. I<sub>SD</sub> ≤ 29 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.	0.31	°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
NVHL050N65S3F	NVHL050N65S3F	TO-247	Tube	N/A	N/A	30 Units

# NVHL050N65S3F

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

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

Drain-to-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA, T <sub>J</sub> = 25°C	650			V
Drain-to-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA, T <sub>J</sub> = 150°C	700			V
Breakdown Voltage Temperature Coefficient	$\frac{\Delta BV_{DSS}}{\Delta T_J}$	I <sub>D</sub> = 10 mA, Referenced to 25°C		640		mV/°C
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 650 V			10	μA
		V <sub>DS</sub> = 520 V, T <sub>C</sub> = 125°C		19		
Gate-to-Body Leakage Current	I <sub>GSS</sub>	V <sub>GS</sub> = ±30 V, V <sub>DS</sub> = 0 V			±100	nA

### ON CHARACTERISTICS

Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.7 mA	3.0		5.0	V
Threshold Temperature Coefficient	$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.7 mA		-8		mV/°C
Static Drain-to-Source On Resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 29 A		42	50	mΩ
Forward Transconductance	g <sub>FS</sub>	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 29 A		32.8		S

### DYNAMIC CHARACTERISTICS

Input Capacitance	C <sub>iss</sub>	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 400 V, f = 1 MHz		5404		pF
Output Capacitance	C <sub>oss</sub>			110		
Reverse Transfer Capacitance	C <sub>rss</sub>			13		
Effective Output Capacitance	C <sub>oss(eff.)</sub>	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V		1119		pF
Energy Related Output Capacitance	C <sub>oss(er.)</sub>	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V		198		pF
Total Gate Charge at 10 V	Q <sub>G(TOT)</sub>	V <sub>GS</sub> = 10 V, V <sub>DS</sub> = 400 V, I <sub>D</sub> = 29 A (Note 4)		123		nC
Threshold Gate Charge	Q <sub>G(TH)</sub>			22.9		
Gate-to-Source Gate Charge	Q <sub>GS</sub>			39.5		
Gate-to-Drain "Miller" Charge	Q <sub>GD</sub>			51.4		
Equivalent Series Resistance	ESR	f = 1 MHz		1.7		Ω

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	t <sub>d(on)</sub>	V <sub>GS</sub> = 10 V, V <sub>DD</sub> = 400 V, I <sub>D</sub> = 29 A, R <sub>g</sub> = 2.2 Ω (Note 4)		38		ns
Turn-On Rise Time	t <sub>r</sub>			47		
Turn-Off Delay Time	t <sub>d(off)</sub>			87		
Turn-Off Fall Time	t <sub>f</sub>			6		

### SOURCE-DRAIN DIODE CHARACTERISTICS

Maximum Continuous Source-to-Drain Diode Forward Current	I <sub>S</sub>	V <sub>GS</sub> = 0 V			58	A
Maximum Pulsed Source-to-Drain Diode Forward Current	I <sub>SM</sub>	V <sub>GS</sub> = 0 V			145	A
Source-to-Drain Diode Forward Voltage	V <sub>SD</sub>	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 29 A			1.3	V
Reverse Recovery Time	t <sub>rr</sub>	V <sub>GS</sub> = 0 V, dI <sub>F</sub> /dt = 100 A/μs, I <sub>SD</sub> = 29 A		133		ns
Charge Time	t <sub>a</sub>			106		
Discharge Time	t <sub>b</sub>			27		
Reverse Recovery Charge	Q <sub>rr</sub>			603		

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

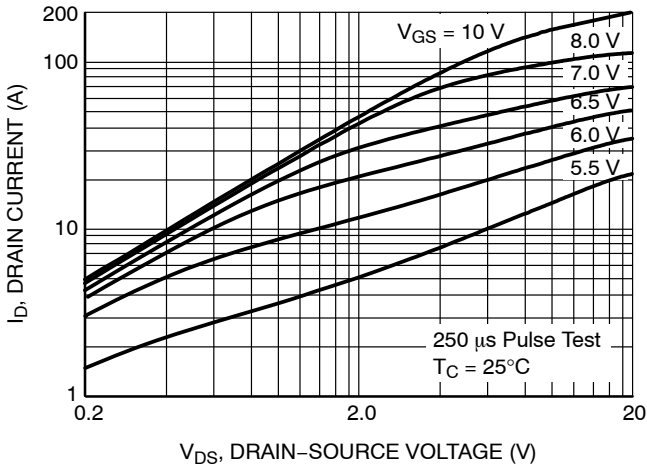


Figure 1. On-Region Characteristics

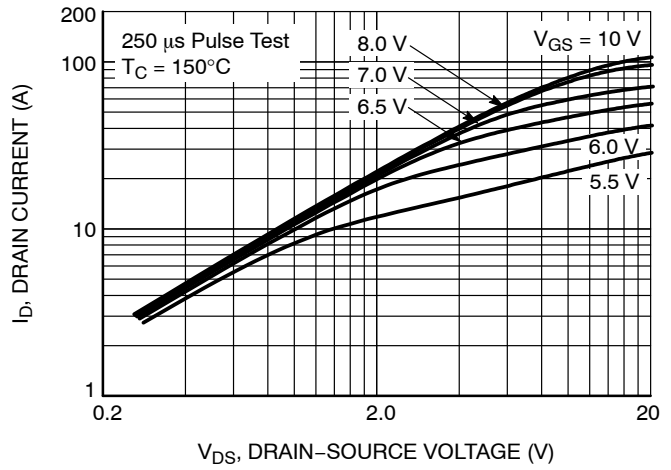


Figure 2. On-Region Characteristics

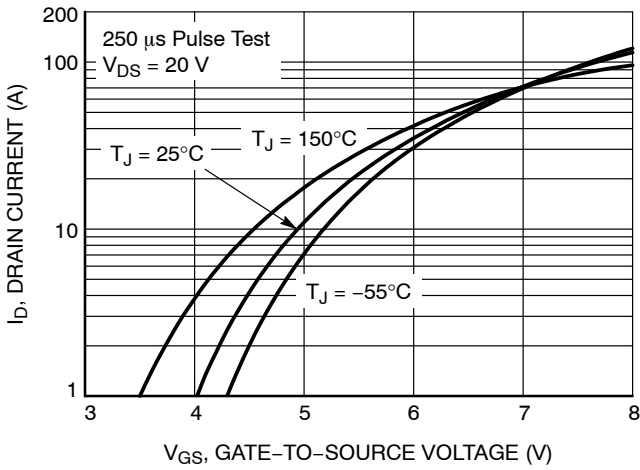


Figure 3. Transfer Characteristics

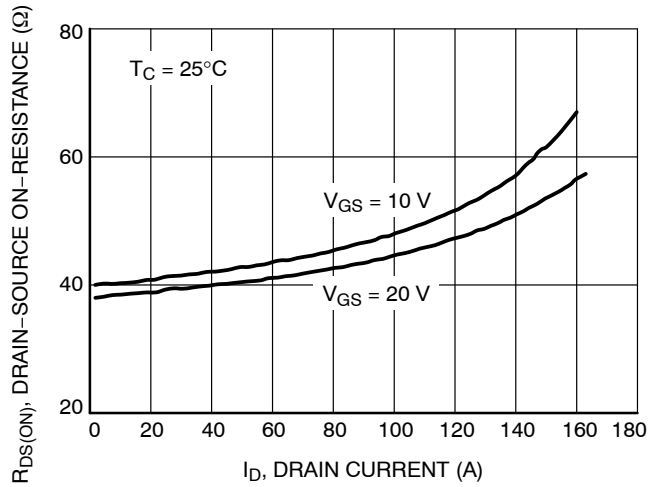


Figure 4. On-Resistance Variation vs. Drain Current and Gate Voltage

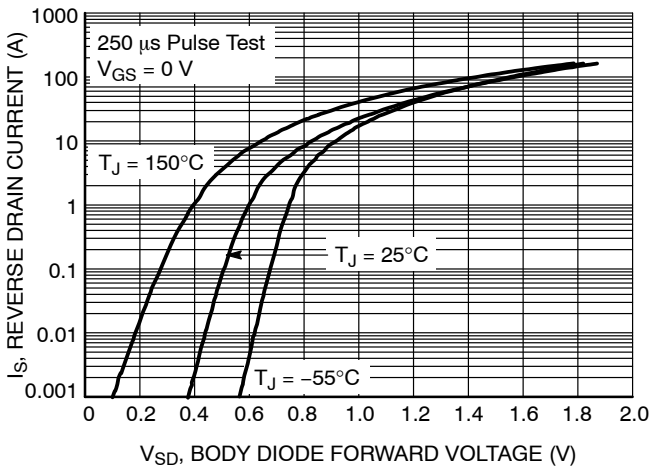


Figure 5. Body Diode Forward Voltage Variation vs. Source Current and Temperature

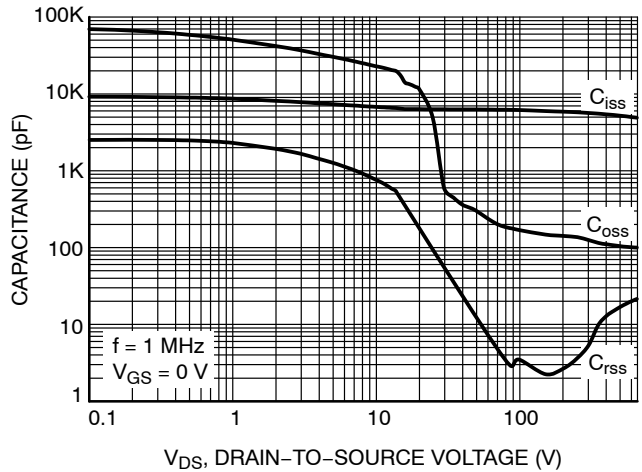
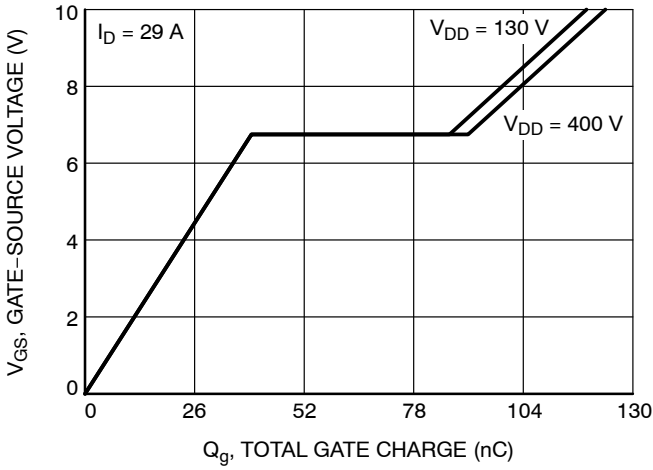


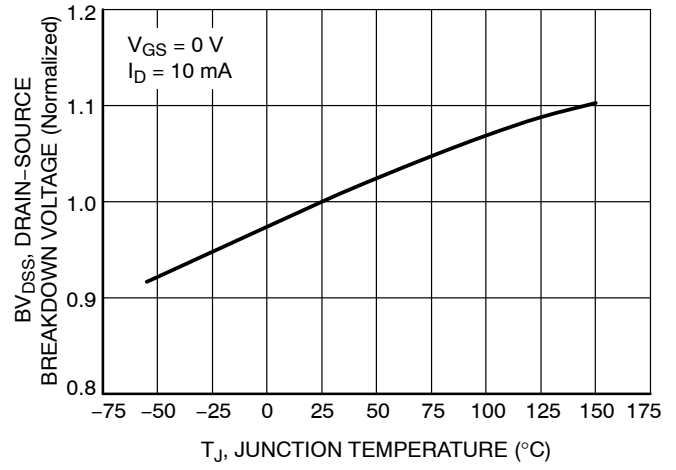
Figure 6. Capacitance Characteristics

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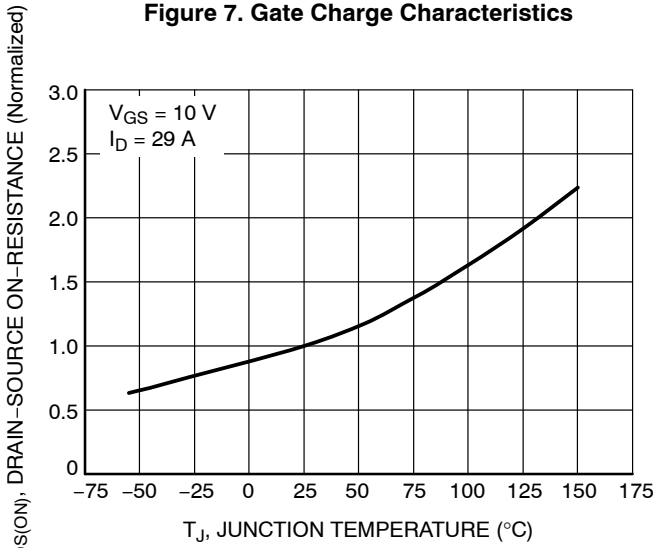
## TYPICAL CHARACTERISTICS



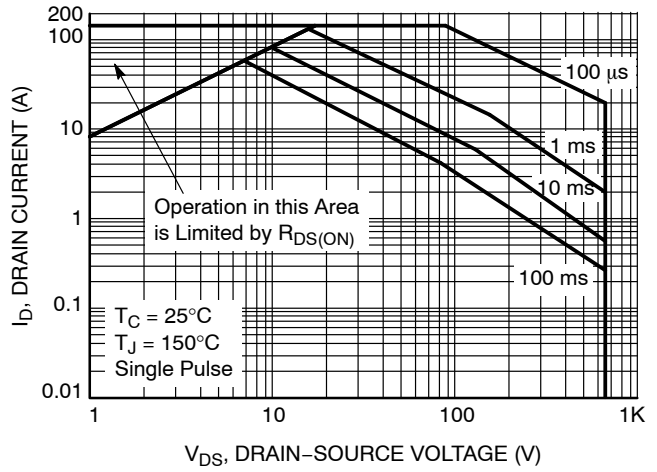
**Figure 7. Gate Charge Characteristics**



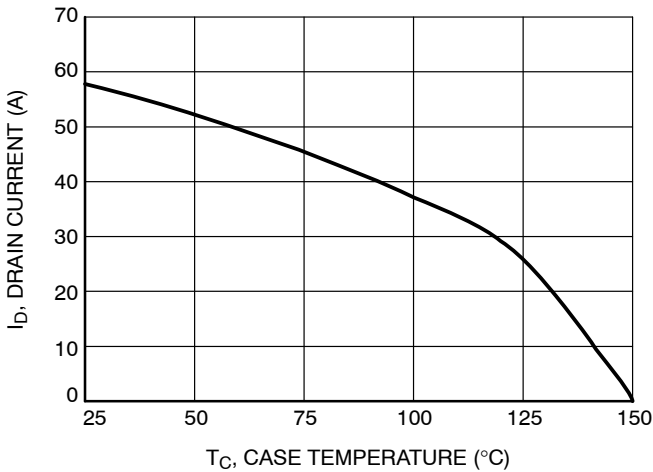
**Figure 8. Breakdown Voltage Variation vs. Temperature**



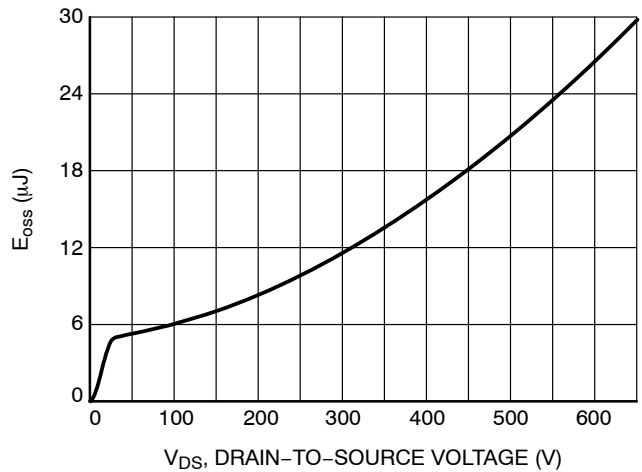
**Figure 9. On-Resistance Variation vs. Temperature**



**Figure 10. Maximum Safe Operating Area**



**Figure 11. Maximum Drain Current vs. Case Temperature**



**Figure 12. E\_OSS vs. Drain-to-Source Voltage**

# NVHL050N65S3F

## TYPICAL CHARACTERISTICS

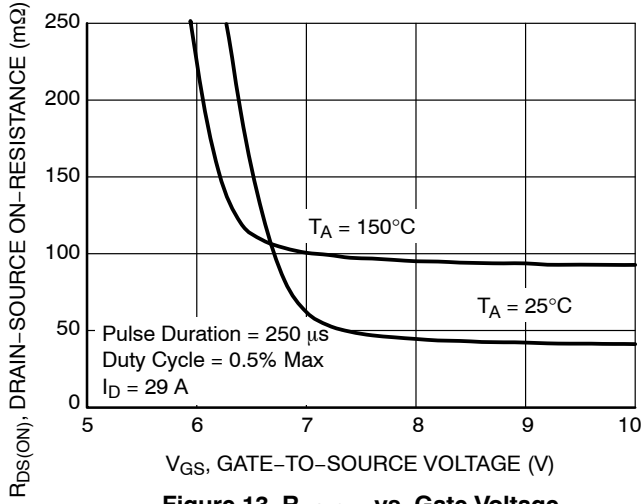


Figure 13.  $R_{DS(ON)}$  vs. Gate Voltage

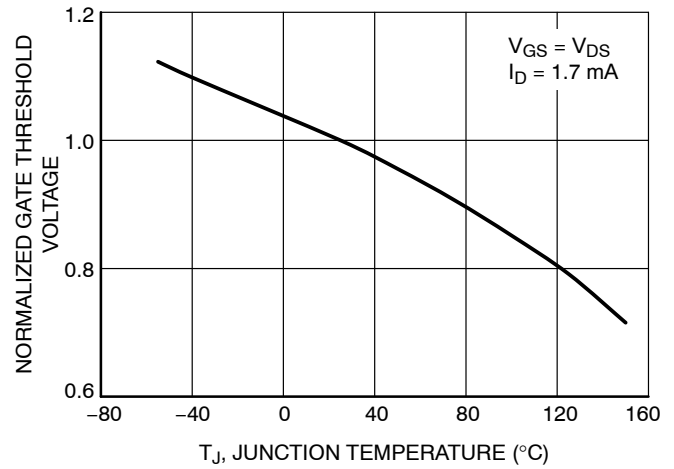


Figure 14. Normalized Gate Threshold Voltage vs. Temperature

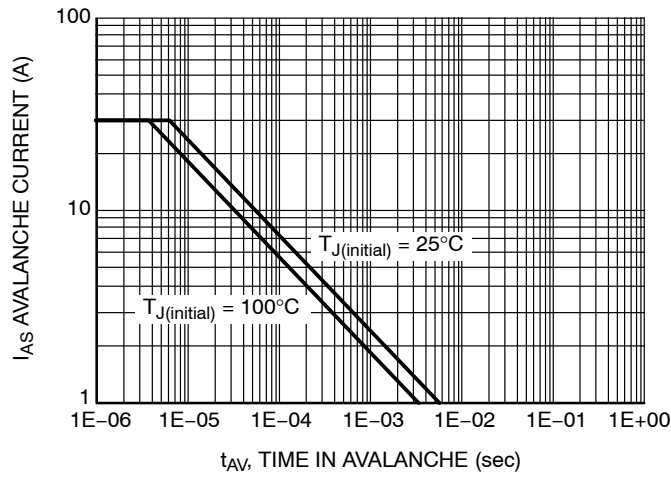


Figure 15. Unclamped Inductive Switching Capability

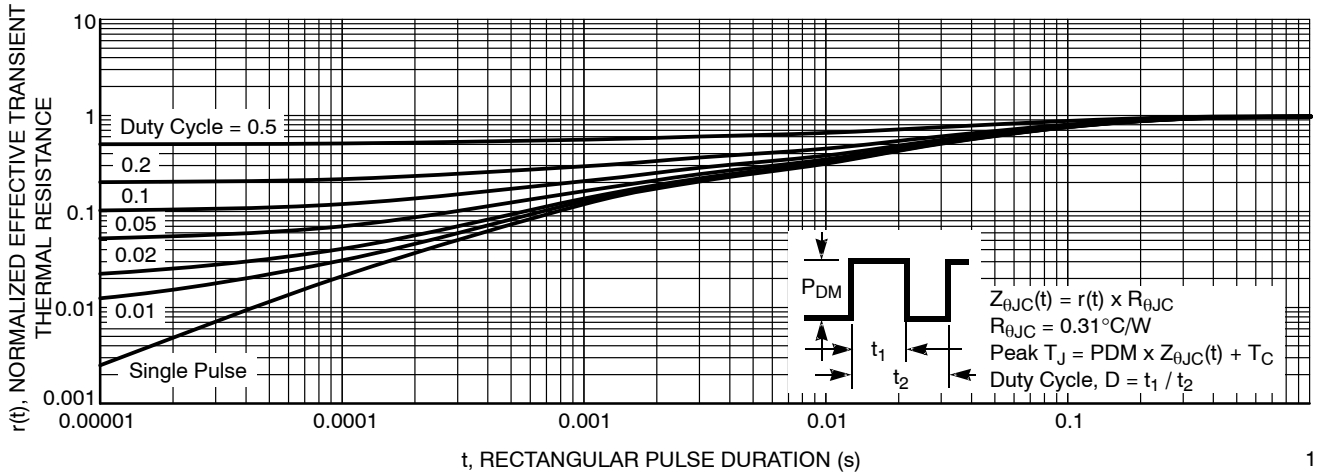


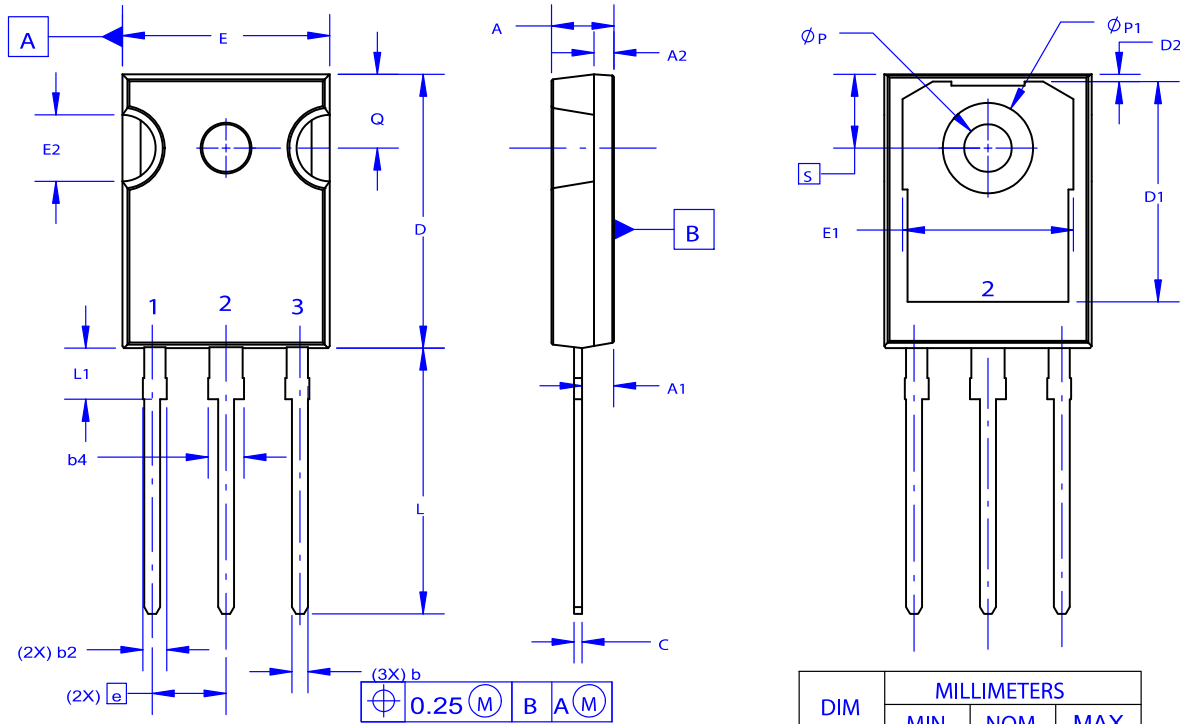
Figure 16. Transient Thermal Response Curve

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# NVHL050N65S3F

## 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.
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