

# MOSFET - Power, N-Channel, SUPERFET® III, FRFET® 650 V, 65 A, 40 mΩ

## Product Preview NVHL040N65S3HF

### 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 HF version provides fast recovery for improved efficiency in high speed switching applications.

### Features

- 700 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 31\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 157\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 1374\text{ pF}$ )
- 100% Avalanche Tested
- NVHL Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; 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 for HEV-EV

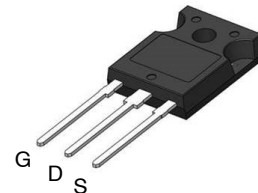
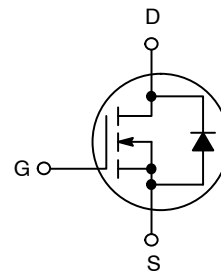
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ON Semiconductor®

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



TO-247 Long Leads  
CASE 340CX

### MARKING DIAGRAM



A = Assembly Plant Code  
 YWW = Data Code (Year & Week)  
 ZZ = Assembly Lot Code  
 NVHL040N65S3HF = Specific Device Code

### ORDERING INFORMATION

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

# NVHL040N65S3HF

## 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)	65
		- Continuous (T <sub>C</sub> = 100°C)	45
I <sub>DM</sub>	Drain Current	- Pulsed (Note 1)	162.5
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)	1009	mJ
I <sub>AS</sub>	Avalanche Current (Note 2)	9	A
E <sub>AR</sub>	Repetitive Avalanche Energy (Note 1)	4.46	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)	446
		- Derate Above 25°C	3.57
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> = 9 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.	0.28	°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
NVHL040N65S3HF	NVHL040N65S3HF	TO-247	Tube	N/A	N/A	30 Units

# NVHL040N65S3HF

## ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ 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> = 15 mA, Referenced to 25°C		0.63		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		28		
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> = 2.1 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> = 32.5 A		31	40	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 32.5 A		45		S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 1 MHz		6655		pF
C <sub>oss</sub>	Output Capacitance			143		pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V		1374		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		250		pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10V	V <sub>DS</sub> = 400 V, I <sub>D</sub> = 32.5 A, V <sub>GS</sub> = 10 V (Note 4)		157		nC
Q <sub>gs</sub>	Gate to Source Gate Charge			49		nC
Q <sub>gd</sub>	Gate to Drain "Miller" Charge			61		nC
ESR	Equivalent Series Resistance	f = 1 MHz		1.1		Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 400 V, I <sub>D</sub> = 32.5 A, V <sub>GS</sub> = 10 V, R <sub>g</sub> = 2.2 Ω (Note 4)		42.2		ns
t <sub>r</sub>	Turn-On Rise Time			27.4		ns
t <sub>d(off)</sub>	Turn-Off Delay Time			103		ns
t <sub>f</sub>	Turn-Off Fall Time			3.4		ns

### SOURCE-DRAIN DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Source to Drain Diode Forward Current			65		A
I <sub>SM</sub>	Maximum Pulsed Source to Drain Diode Forward Current			162.5		A
V <sub>SD</sub>	Source to Drain Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 32.5 A			1.3	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>DD</sub> = 400 V, I <sub>SD</sub> = 32.5 A, dI <sub>F</sub> /dt = 100 A/μs		137		ns
Q <sub>rr</sub>	Reverse Recovery Charge			792		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

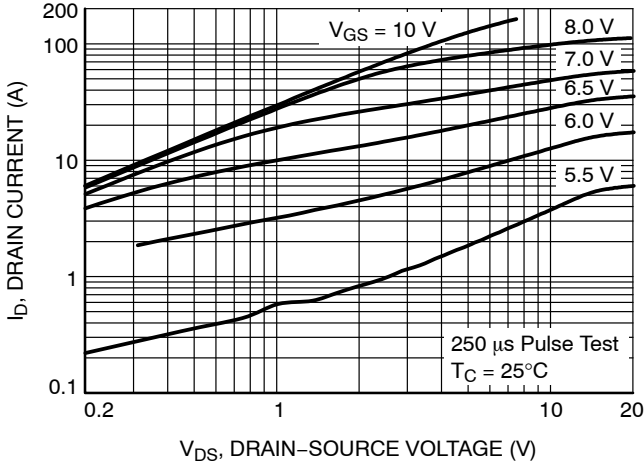


Figure 1. On-Region Characteristics

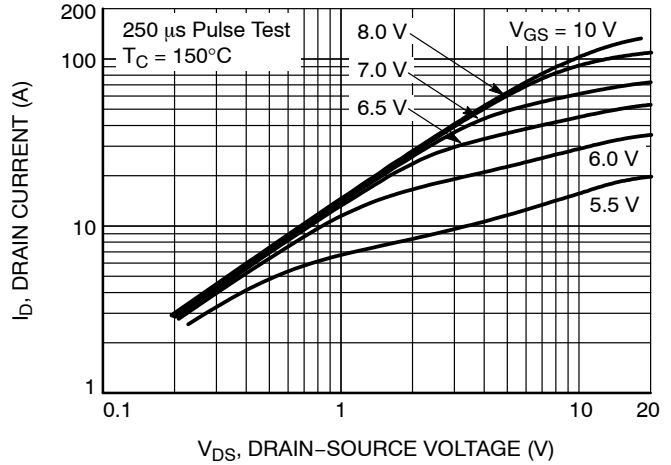


Figure 2. On-Region Characteristics

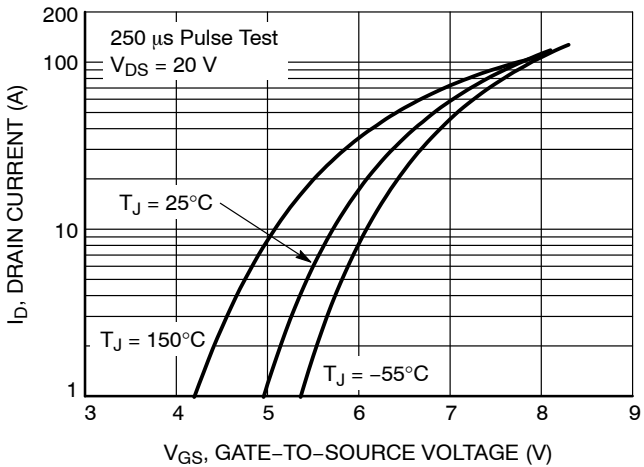


Figure 3. Transfer Characteristics

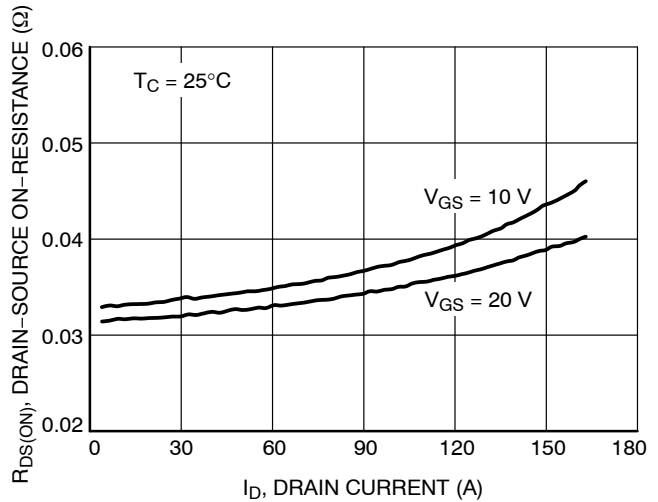


Figure 4. On-Resistance Variation vs. Drain Current and Gate Voltage

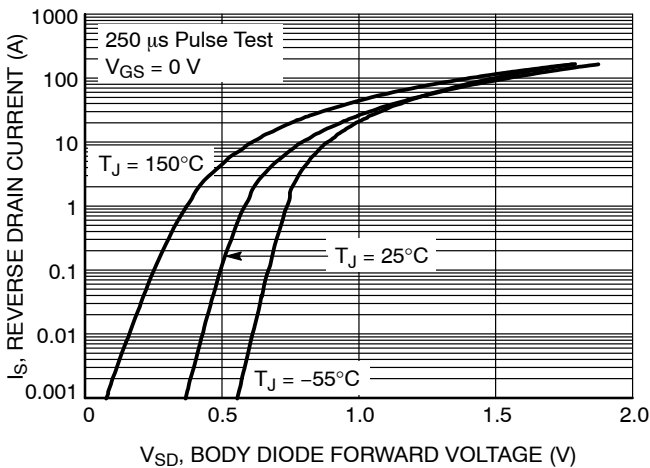


Figure 5. Body Diode Forward Voltage Variation vs. Source Current and Temperature

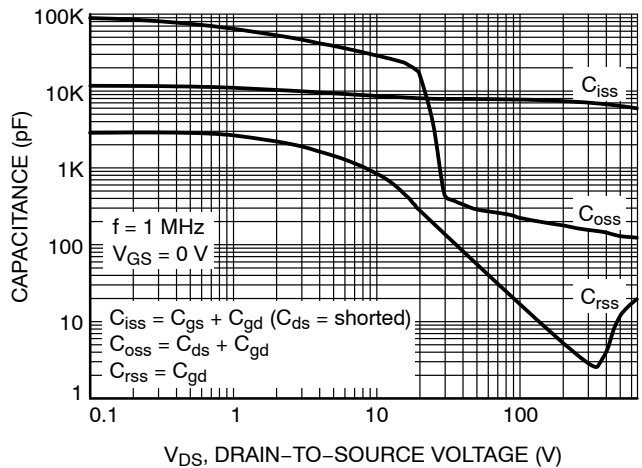


Figure 6. Capacitance Characteristics

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## TYPICAL CHARACTERISTICS

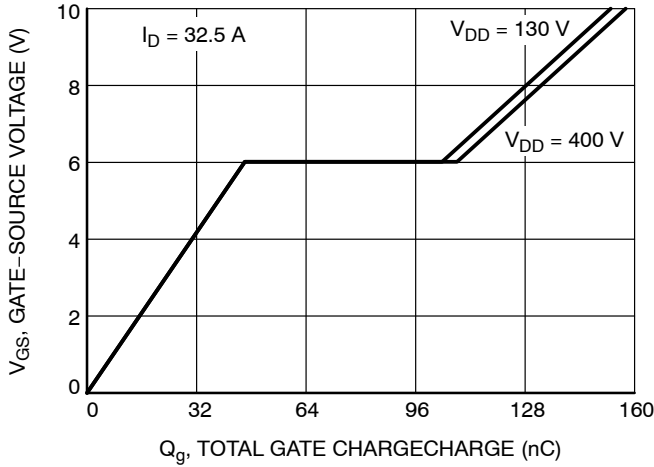


Figure 7. Gate Charge Characteristics

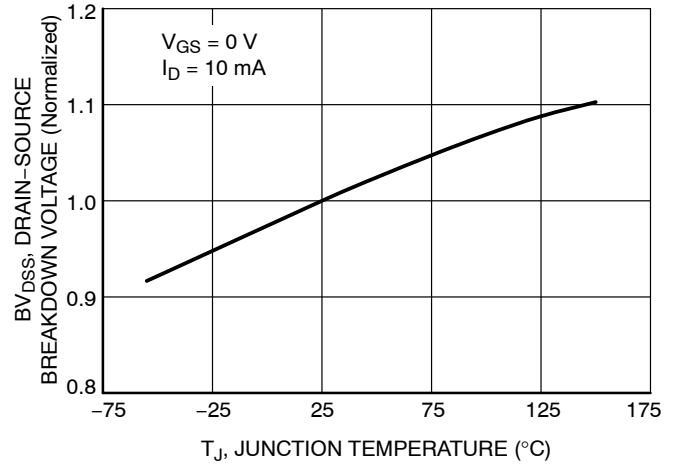


Figure 8. Breakdown Voltage Variation vs. Temperature

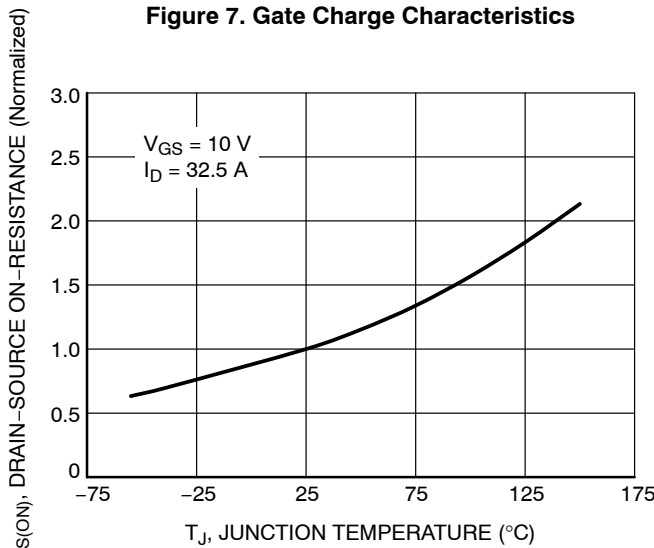


Figure 9. On-Resistance Variation vs. Temperature

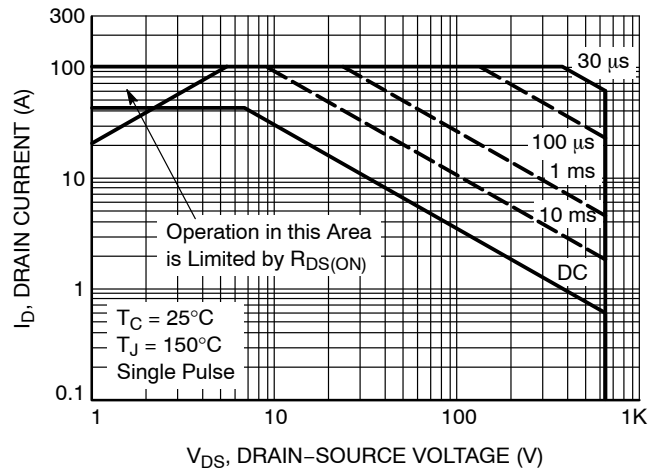


Figure 10. Maximum Safe Operating Area

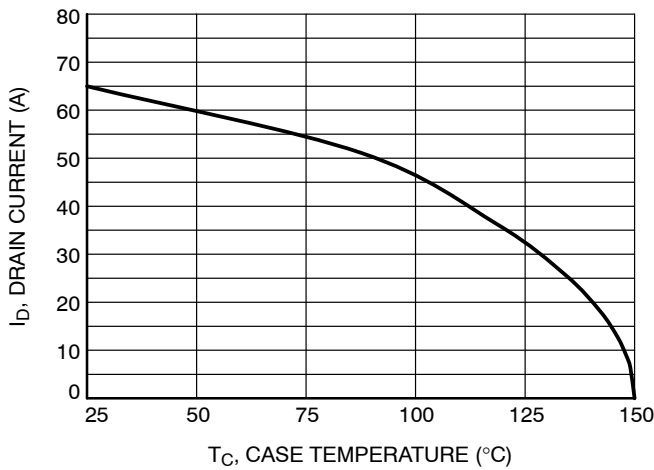


Figure 11. Maximum Drain Current vs. Case Temperature

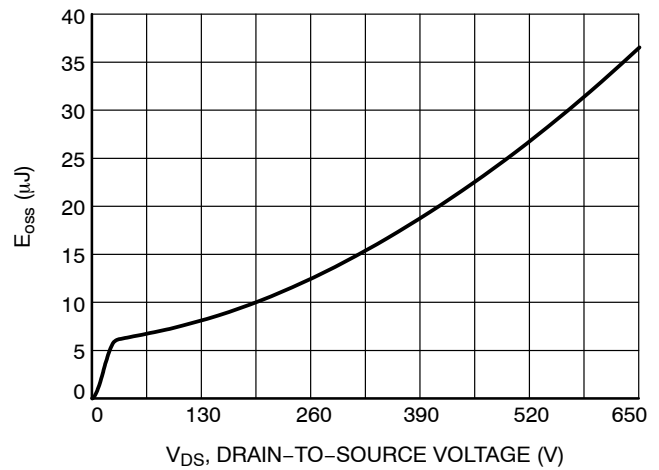


Figure 12. E\_OSS vs. Drain-to-Source Voltage

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## TYPICAL CHARACTERISTICS

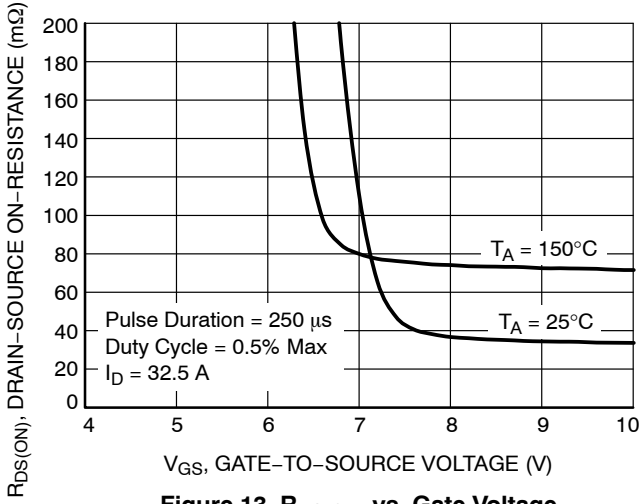


Figure 13.  $R_{DS(ON)}$  vs. Gate Voltage

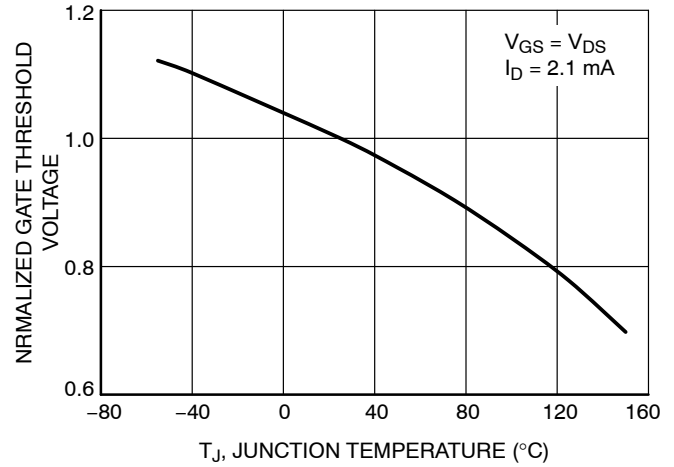
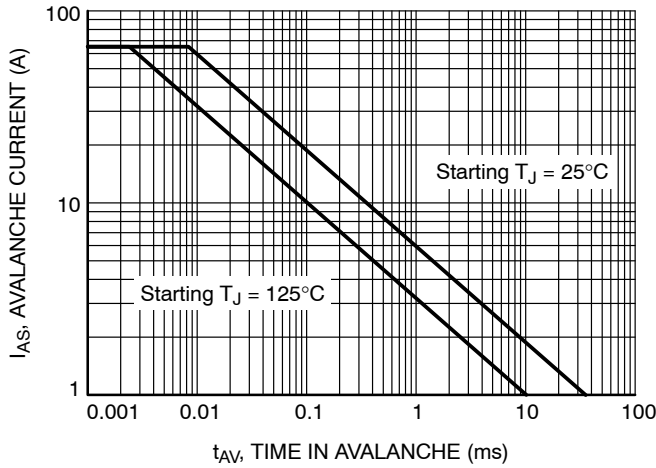


Figure 14. Normalized Gate Threshold Voltage vs. Temperature



If  $R = 0$   
 $t_{AV} = (L)(I_{AS}) / (1.3 \cdot \text{RATED } BV_{DSS} - V_{DD})$   
 If  $R \neq 0$   
 $t_{AV} = (L/R) \ln[(I_{AS} \cdot R) / (1.3 \cdot \text{RATED } BV_{DSS} - V_{DD}) + 1]$

NOTE: Refer to Application Notes AN7514 and AN7515

Figure 15. Unclamped Inductive Switching Capability

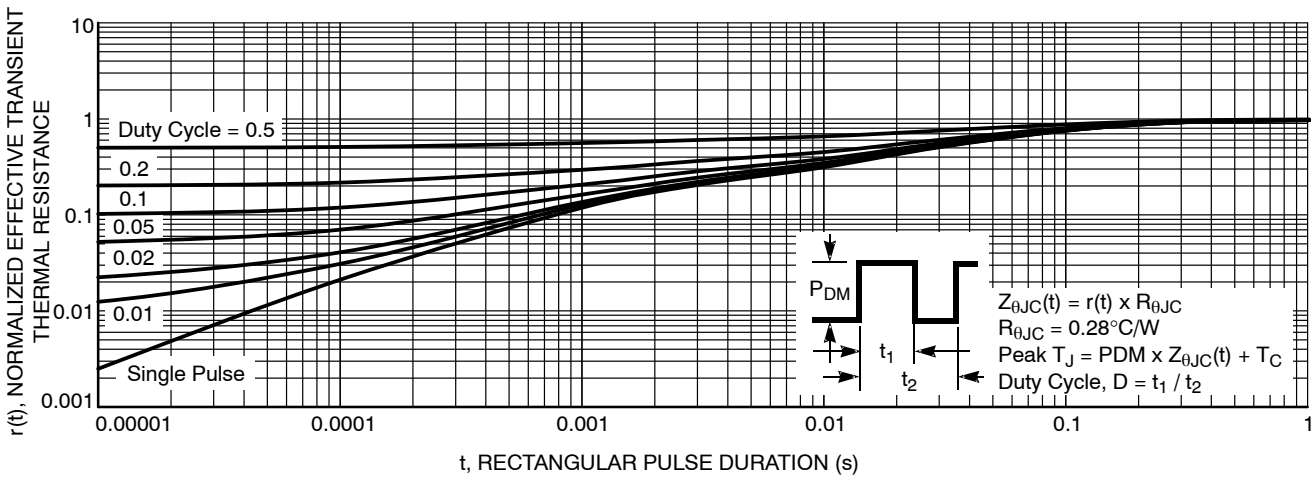


Figure 16. Transient Thermal Response Curve

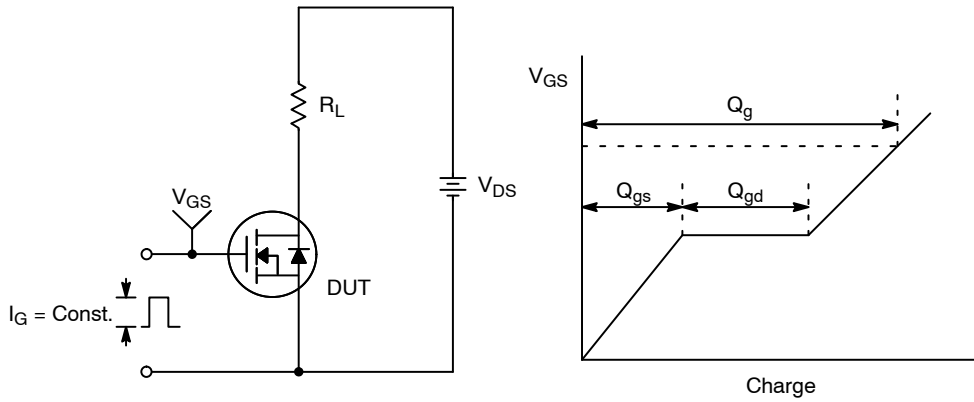


Figure 17. Gate Charge Test Circuit & Waveform

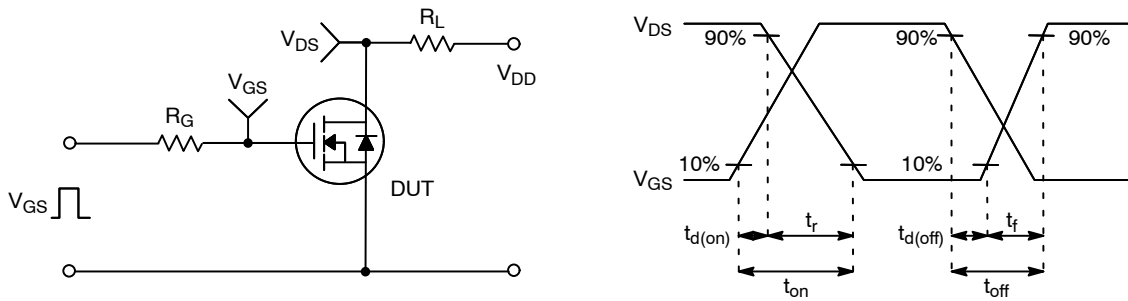


Figure 18. Resistive Switching Test Circuit & Waveforms

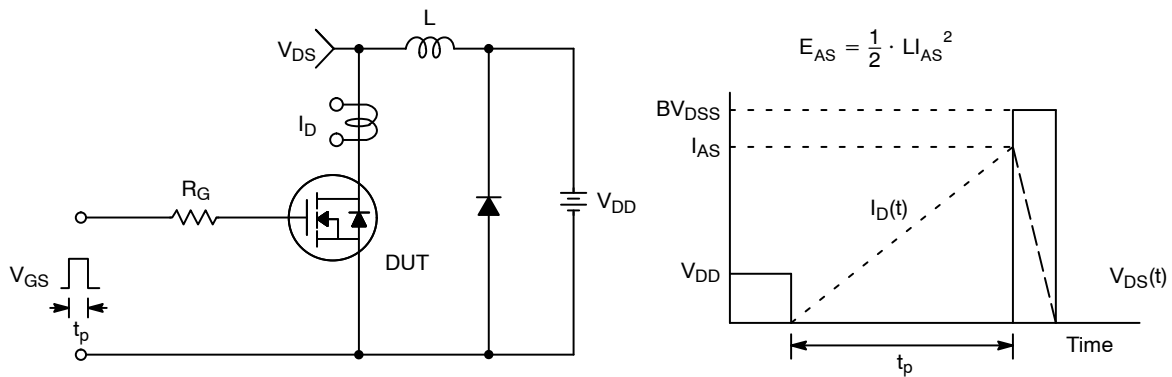
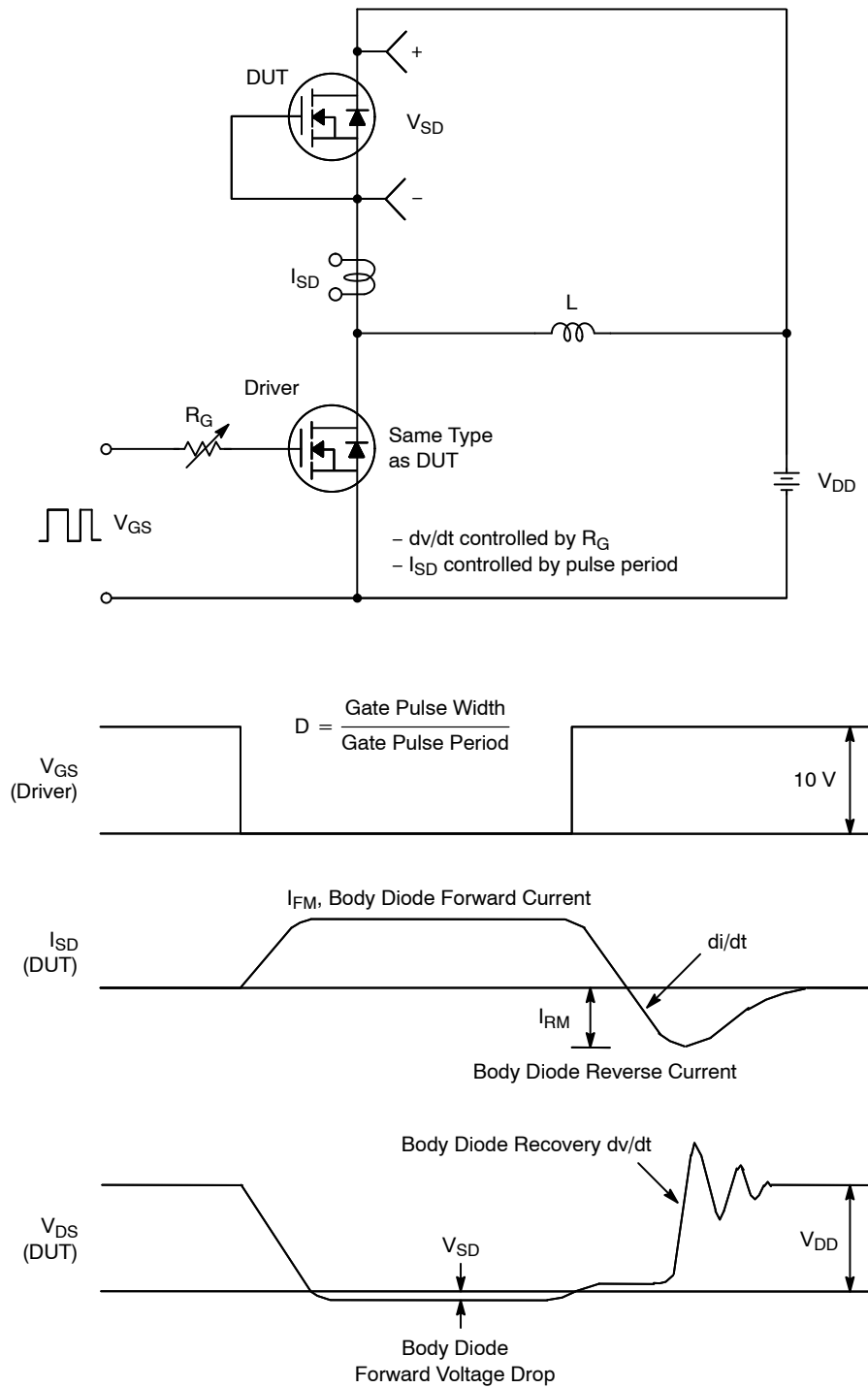


Figure 19. Unclamped Inductive Switching Test Circuit & Waveforms

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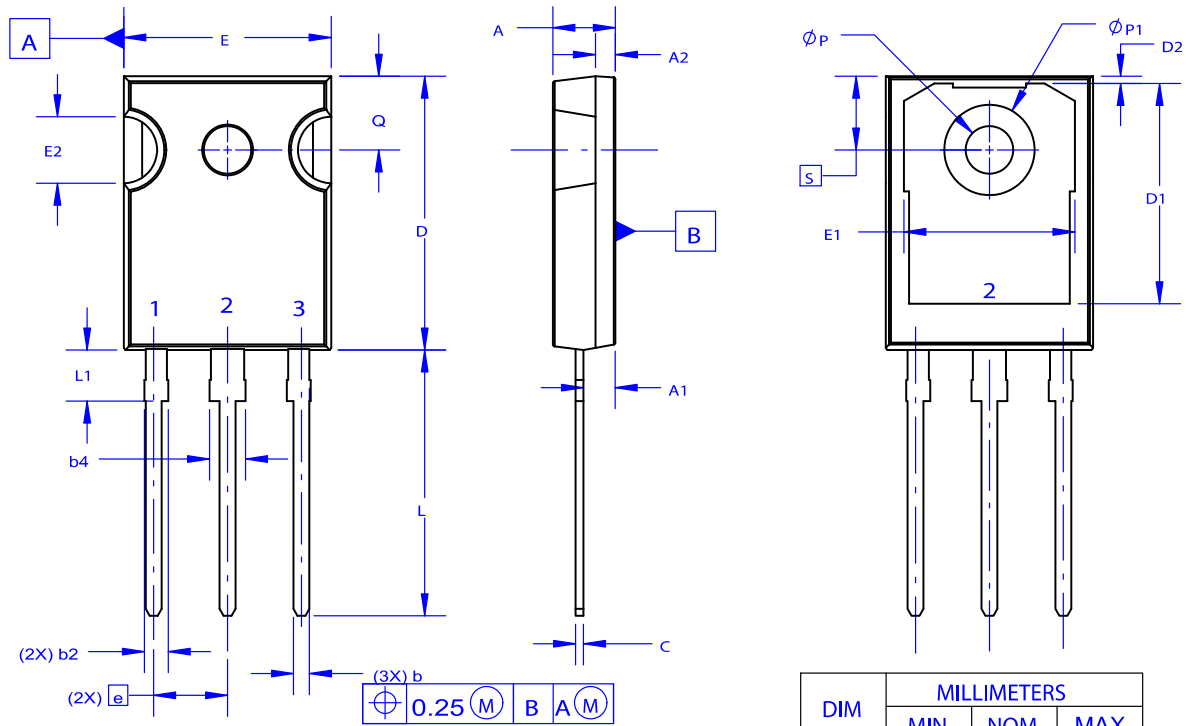


**Figure 20. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**

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## PACKAGE DIMENSIONS


TO-247-3LD  
CASE 340CX  
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.

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