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# MOSFET – Single N-Channel, SUPERFET® III, FRFET® 650 V, 50 mΩ, 58 A



## NVH4L050N65S3F

### Features

- Ultra Low Gate Charge & Low Effective Output Capacitance
- Lower FOM ( $R_{DS(on)}$  max. x  $Q_g$  typ. &  $R_{DS(on)}$  max. x  $E_{OSS}$ )
- 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 ( $f > 1$ Hz)	$V_{GSS}$	$\pm 30$	V
Drain Current – Continuous ( $T_C = 25^\circ\text{C}$ )	$I_D$	58	A
Drain Current – Continuous ( $T_C = 100^\circ\text{C}$ )	$I_D$	36	A
Drain Current – Pulsed (Note 3)	$I_{DM}$	145	A
Power Dissipation ( $T_C = 25^\circ\text{C}$ )	$P_D$	403	W
Power Dissipation – Derate Above $25^\circ\text{C}$	$P_D$	3.23	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)	$E_{AS}$	830	mJ
Repetitive Avalanche Energy (Note 3)	$E_{AR}$	4.03	mJ
MOSFET dv/dt	dv/dt	100	V/ns
Peak Diode Recovery dv/dt (Note 5)	dv/dt	50	V/ns
Max. Lead Temperature for Soldering Purposes (1/8" from case for 5 s)	$T_L$	300	$^\circ\text{C}$

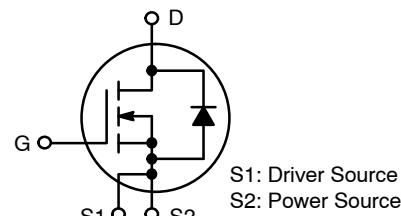
### THERMAL CHARACTERISTICS

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case, Max. (Notes 1, 2)	$R_{\theta JC}$	0.31	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Ambient, Max. (Notes 1, 2)	$R_{\theta JA}$	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.

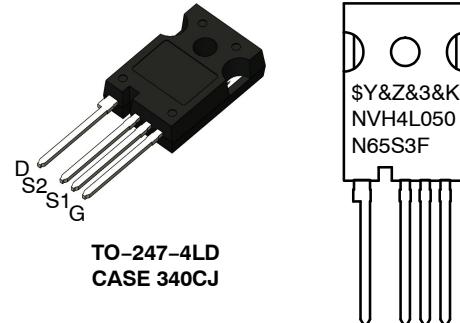
1. The entire application environment impacts the thermal resistance values shown. They are not constants and are only valid for the particular conditions noted.
2. Assembled to an infinite heatsink with perfect heat transfer from the case (assumes 0 K/W thermal interface).
3. Repetitive rating: pulse-width limited by maximum junction temperature.
4.  $I_{AS} = 7.5$  A,  $R_G = 25$  Ω, starting  $T_J = 25^\circ\text{C}$ .
5.  $I_{SD} \leq 29$  A,  $di/dt \leq 200$  A/ $\mu\text{s}$ ,  $V_{DD} \leq 400$  V, starting  $T_J = 25^\circ\text{C}$ .

$V_{DSS}$	$R_{DS(ON)}$ MAX	$I_D$ MAX
650 V	50 mΩ @ 10 V	58 A



**POWER MOSFET**

### MARKING DIAGRAM



$\$Y$  = ON Semiconductor Logo  
 $\&Z$  = Assembly Plant Code  
 $\&3$  = Data Code (Year & Week)  
 $\&K$  = Lot  
 NVH4L050N65S3F = Specific Device Code

### ORDERING INFORMATION

Device	Package	Shipping
NVH4L050N65S3F	TO-247-4LD (Pb-Free)	30 Units / Tube

# NVH4L050N65S3F

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>						
Drain-to-Source Breakdown Voltage	$\text{BV}_{\text{DSS}}$	$V_{\text{GS}} = 0 \text{ V}$ , $I_D = 1 \text{ mA}$ , $T_J = 25^\circ\text{C}$	650			V
Drain-to-Source Breakdown Voltage	$\text{BV}_{\text{DSS}}$	$V_{\text{GS}} = 0 \text{ V}$ , $I_D = 1 \text{ mA}$ , $T_J = 150^\circ\text{C}$	700			V
Breakdown Voltage Temperature Coefficient	$\Delta \text{BV}_{\text{DSS}}/\Delta T_J$	$I_D = 10 \text{ mA}$ , Referenced to $25^\circ\text{C}$		640		$\text{mV}/^\circ\text{C}$
Zero Gate Voltage Drain Current	$I_{\text{DSS}}$	$V_{\text{GS}} = 0 \text{ V}$ , $V_{\text{DS}} = 650 \text{ V}$		10		$\mu\text{A}$
		$V_{\text{DS}} = 520 \text{ V}$ , $T_C = 125^\circ\text{C}$		19		
Gate-to-Body Leakage Current	$I_{\text{GSS}}$	$V_{\text{GS}} = \pm 30 \text{ V}$ , $V_{\text{DS}} = 0 \text{ V}$			$\pm 100$	nA
<b>ON CHARACTERISTICS</b>						
Gate Threshold Voltage	$V_{\text{GS}(\text{th})}$	$V_{\text{GS}} = V_{\text{DS}}$ , $I_D = 1.7 \text{ mA}$	3.0		5.0	V
Threshold Temperature Coefficient	$\Delta V_{\text{GS}(\text{th})}/\Delta T_J$	$V_{\text{GS}} = V_{\text{DS}}$ , $I_D = 1.7 \text{ mA}$		-8		$\text{mV}/^\circ\text{C}$
Static Drain-to-Source On Resistance	$R_{\text{DS}(\text{on})}$	$V_{\text{GS}} = 10 \text{ V}$ , $I_D = 29 \text{ A}$		40.4	50	$\text{m}\Omega$
Forward Transconductance	$g_{\text{FS}}$	$V_{\text{DS}} = 20 \text{ V}$ , $I_D = 29 \text{ A}$		31.8		S
<b>DYNAMIC CHARACTERISTICS</b>						
Input Capacitance	$C_{\text{iss}}$	$V_{\text{GS}} = 0 \text{ V}$ , $V_{\text{DS}} = 400 \text{ V}$ , $f = 1 \text{ MHz}$		4855		pF
Output Capacitance	$C_{\text{oss}}$			112		
Reverse Transfer Capacitance	$C_{\text{rss}}$			14		
Effective Output Capacitance	$C_{\text{oss}(\text{eff.})}$	$V_{\text{DS}} = 0 \text{ V}$ to $400 \text{ V}$ , $V_{\text{GS}} = 0 \text{ V}$		1070		pF
Energy Related Output Capacitance	$C_{\text{oss}(\text{er.})}$	$V_{\text{DS}} = 0 \text{ V}$ to $400 \text{ V}$ , $V_{\text{GS}} = 0 \text{ V}$		198		pF
Total Gate Charge at 10 V	$Q_{\text{G}(\text{TOT})}$	$V_{\text{GS}} = 10 \text{ V}$ , $V_{\text{DS}} = 400 \text{ V}$ , $I_D = 29 \text{ A}$ (Note 6)		123.8		nC
Threshold Gate Charge	$Q_{\text{G}(\text{TH})}$			22.9		
Gate-to-Source Gate Charge	$Q_{\text{GS}}$			39		
Gate-to-Drain "Miller" Charge	$Q_{\text{GD}}$			48.6		
Equivalent Series Resistance	ESR	$f = 1 \text{ MHz}$		1.7		$\Omega$
<b>SWITCHING CHARACTERISTICS</b>						
Turn-On Delay Time	$t_{\text{d}(\text{on})}$	$V_{\text{GS}} = 10 \text{ V}$ , $V_{\text{DD}} = 400 \text{ V}$ , $I_D = 29 \text{ A}$ , $R_g = 2.2 \Omega$ (Note 6)		38		ns
Turn-On Rise Time	$t_r$			40		ns
Turn-Off Delay Time	$t_{\text{d}(\text{off})}$			89		ns
Turn-Off Fall Time	$t_f$			5		ns
<b>SOURCE-DRAIN DIODE CHARACTERISTICS</b>						
Maximum Continuous Source-to-Drain Diode Forward Current	$I_S$	$V_{\text{GS}} = 0 \text{ V}$			58	A
Maximum Pulsed Source-to-Drain Diode Forward Current	$I_{\text{SM}}$	$V_{\text{GS}} = 0 \text{ V}$			145	A
Source-to-Drain Diode Forward Voltage	$V_{\text{SD}}$	$V_{\text{GS}} = 0 \text{ V}$ , $I_{\text{SD}} = 29 \text{ A}$			1.3	V
Reverse Recovery Time	$t_{\text{rr}}$	$V_{\text{GS}} = 0 \text{ V}$ , $dI_F/dt = 100 \text{ A}/\mu\text{s}$ , $I_{\text{SD}} = 29 \text{ A}$		129		ns
Charge Time	$t_a$			110		
Discharge Time	$t_b$			19		
Reverse Recovery Charge	$Q_{\text{rr}}$			588		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.

6. Essentially independent of operating temperature typical characteristics.

TYPICAL CHARACTERISTICS

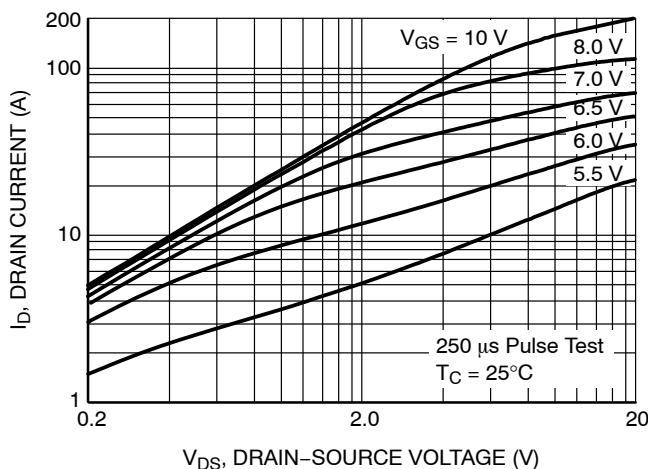


Figure 1. On-Region Characteristics

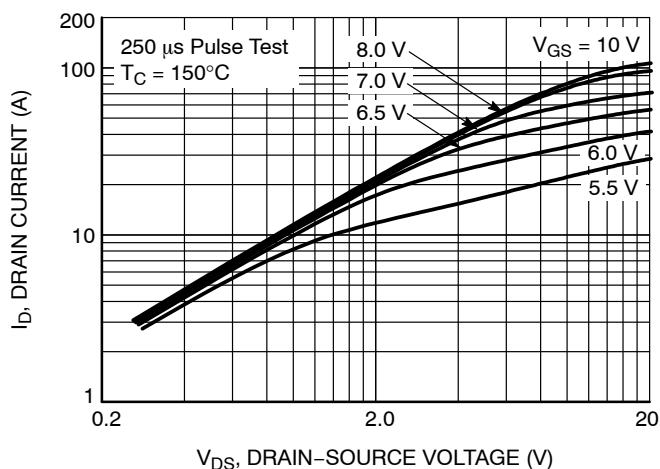


Figure 2. On-Region Characteristics

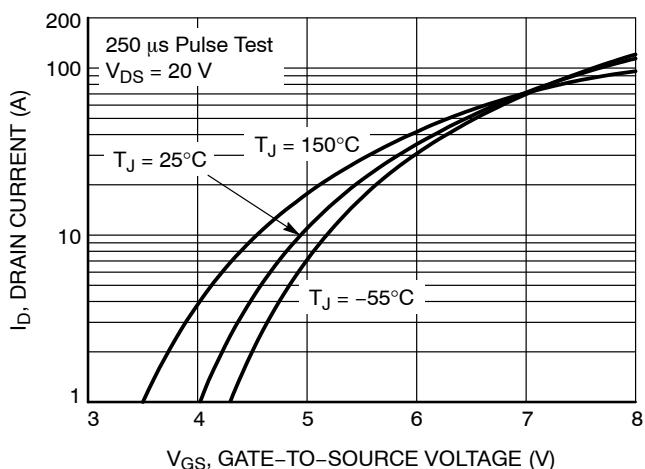


Figure 3. Transfer Characteristics

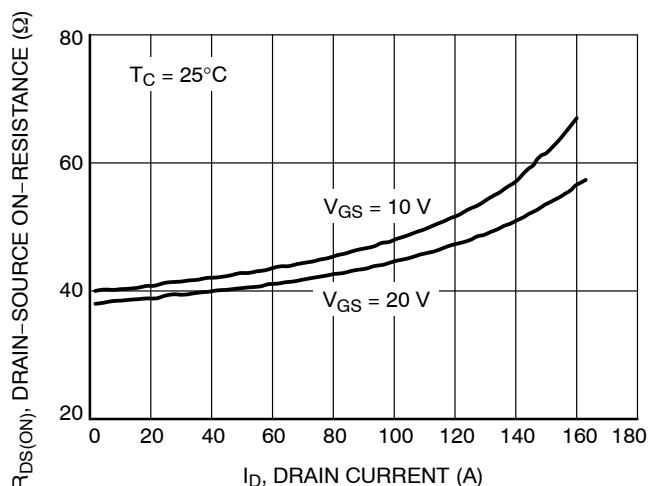


Figure 4. On-Resistance Variation vs. Drain Current and Gate Voltage

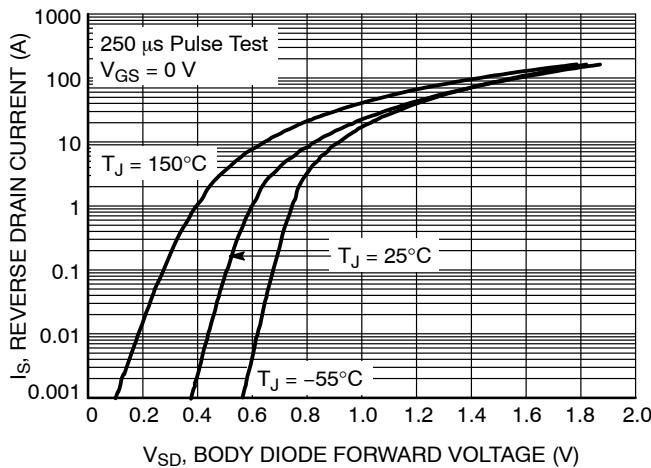


Figure 5. Body Diode Forward Voltage Variation vs. Source Current and Temperature

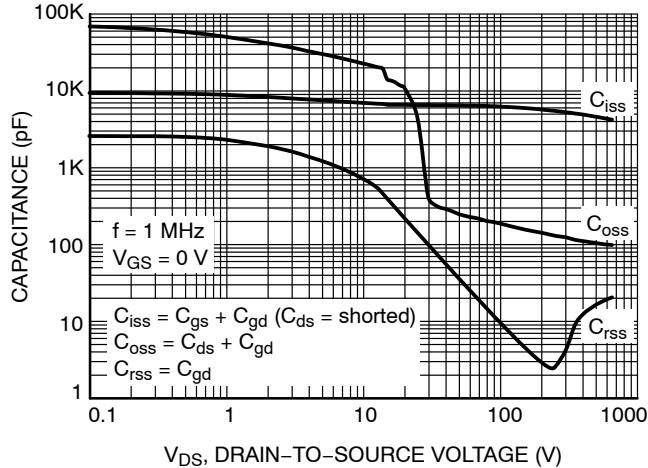
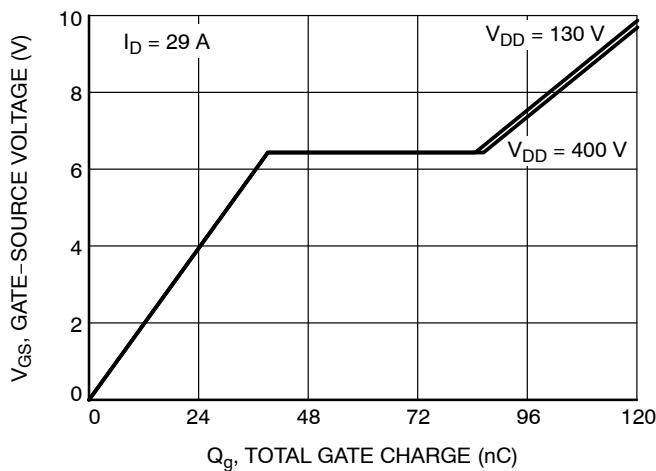
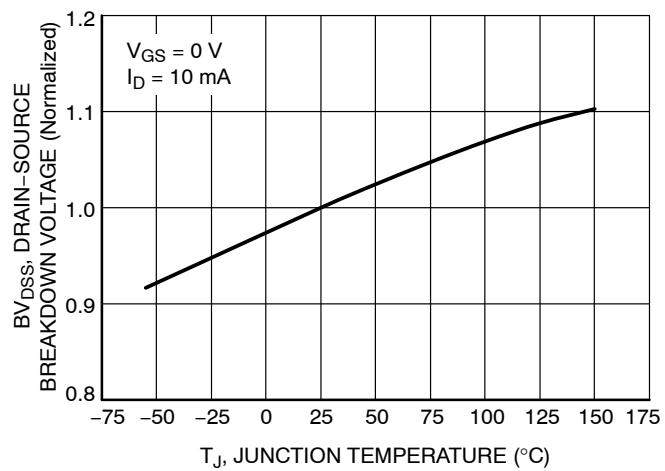
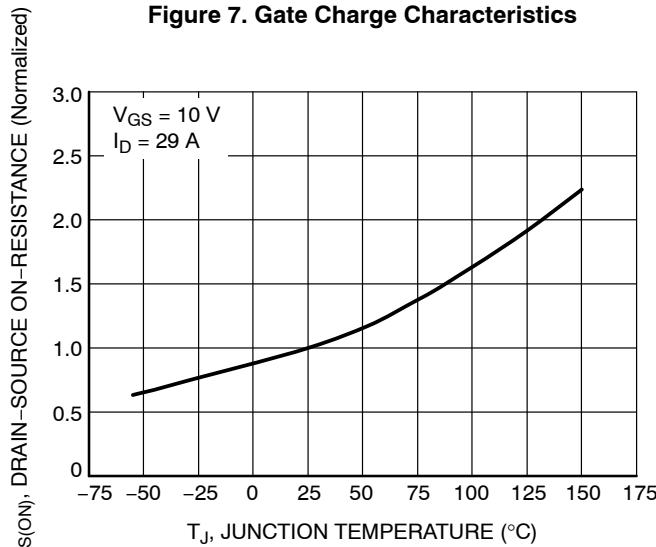
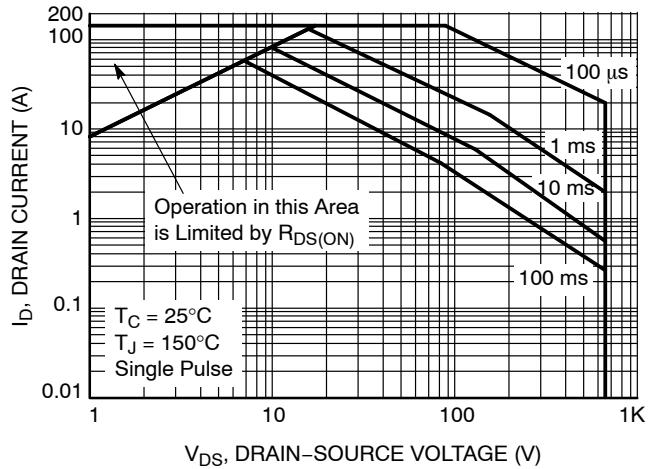
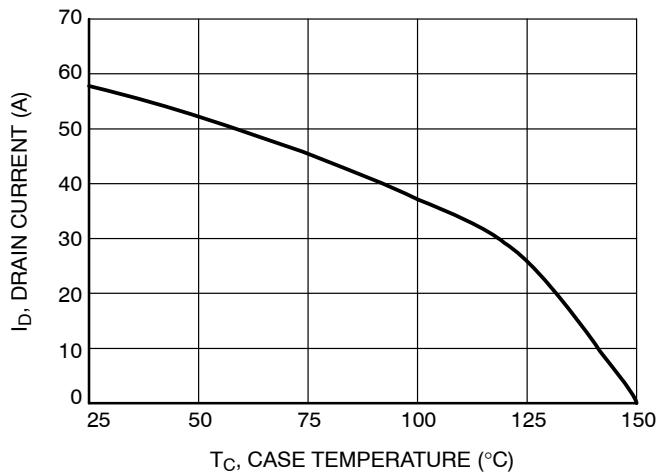
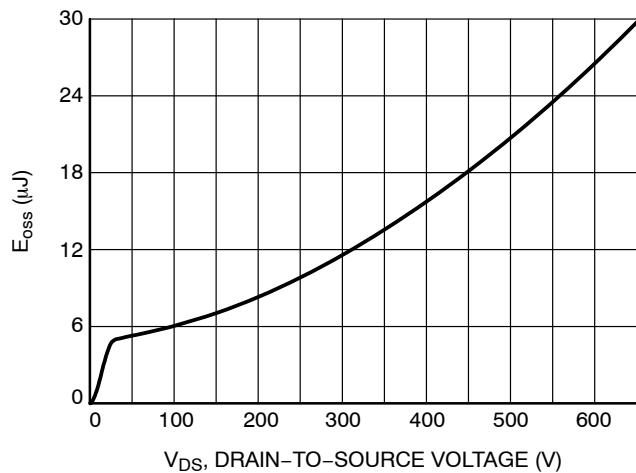


Figure 6. Capacitance Characteristics

**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. EOSS vs. Drain-to-Source Voltage**

## TYPICAL CHARACTERISTICS

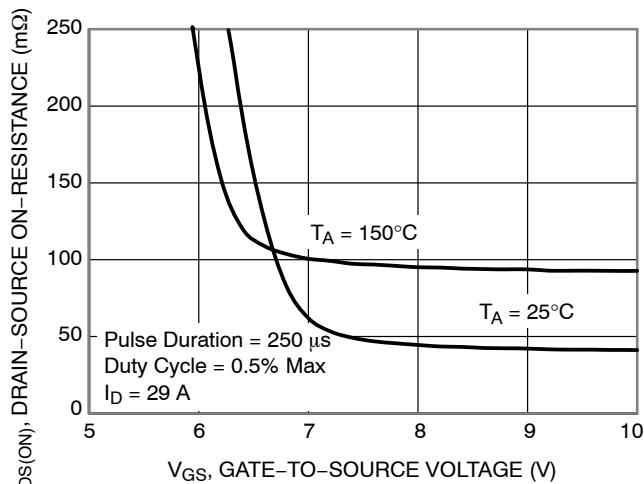


Figure 13.  $R_{DS(ON)}$  vs. Gate Voltage

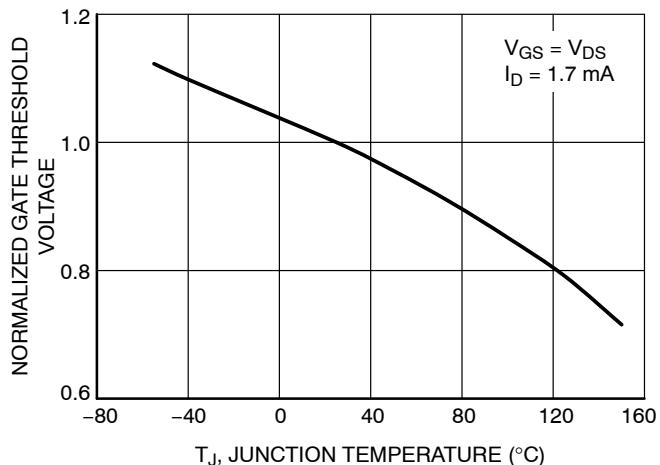


Figure 14. Normalized Gate Threshold Voltage vs. Temperature

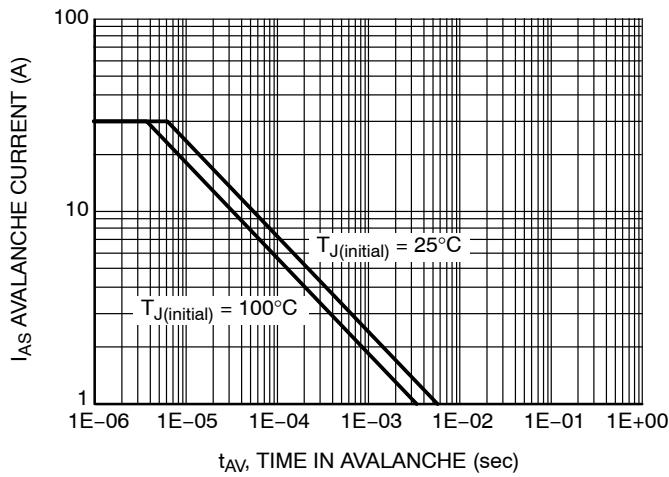


Figure 15. Unclamped Inductive Switching Capability

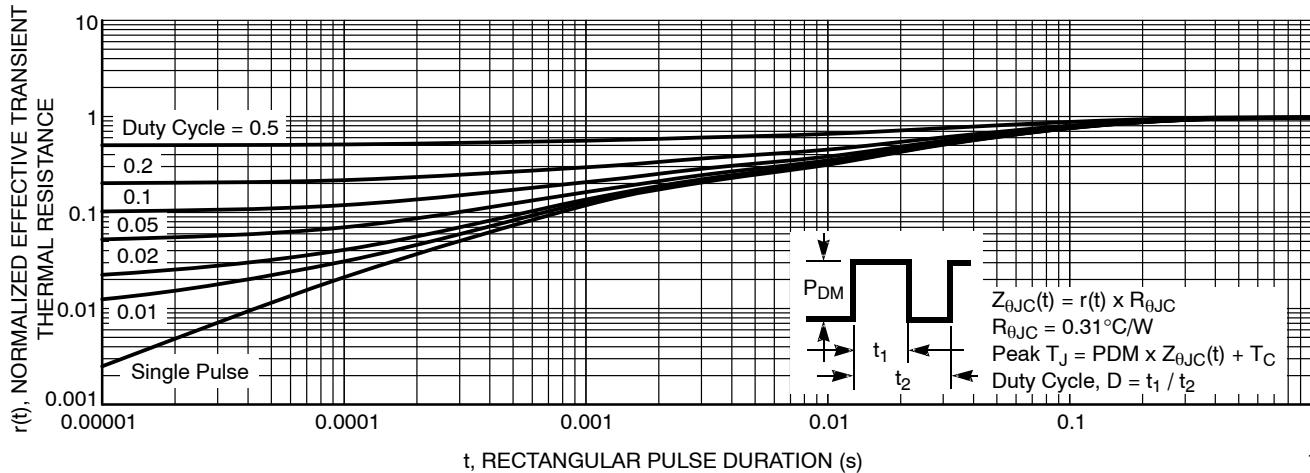
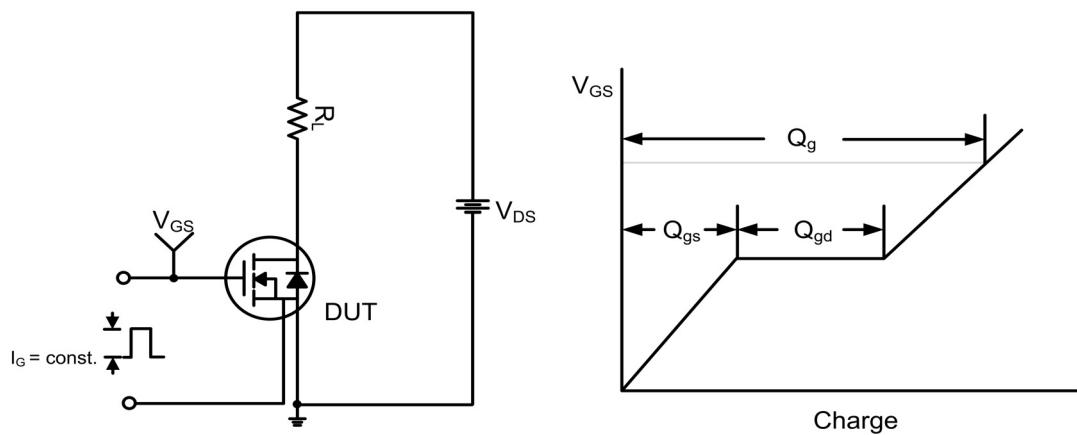
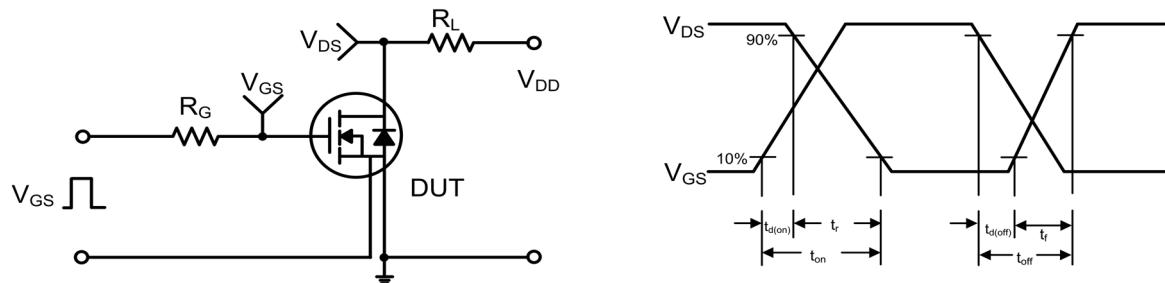
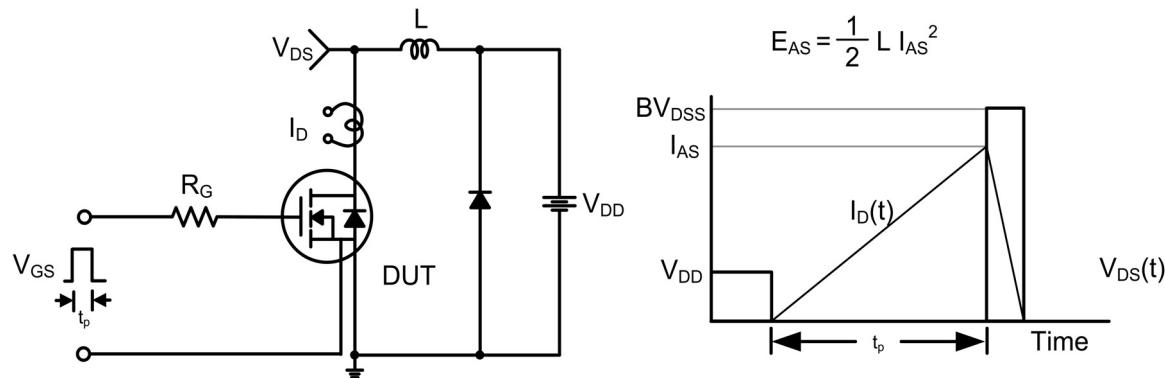


Figure 16. Transient Thermal Response Curve


**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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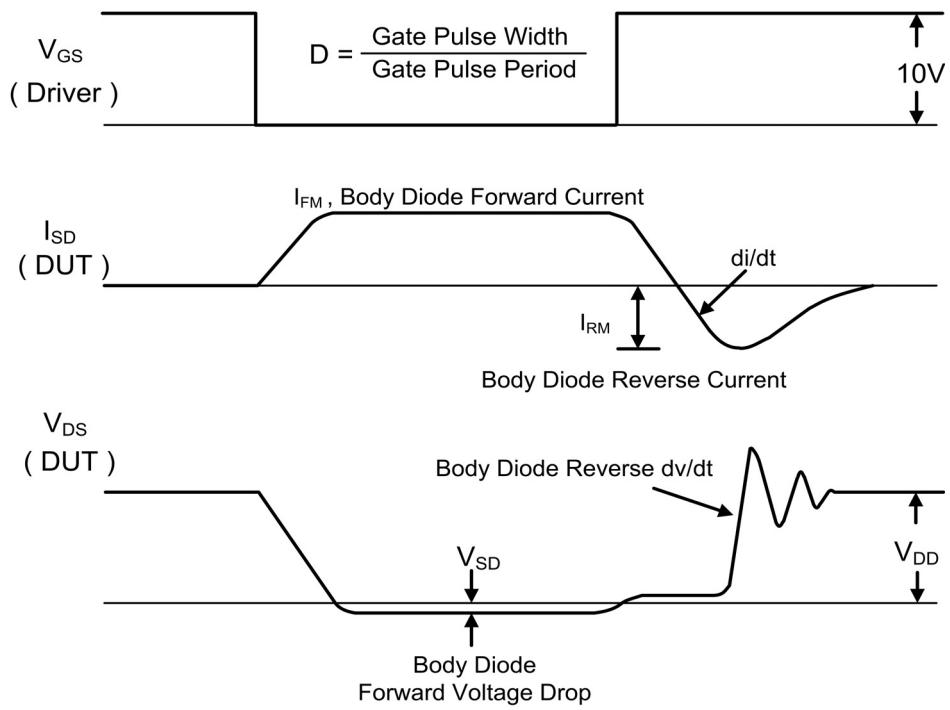
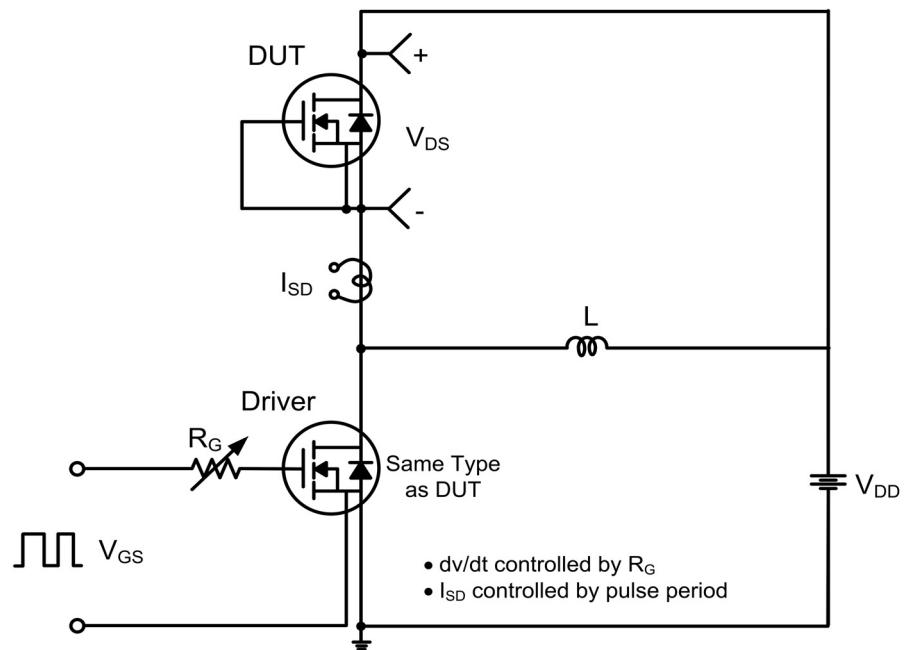
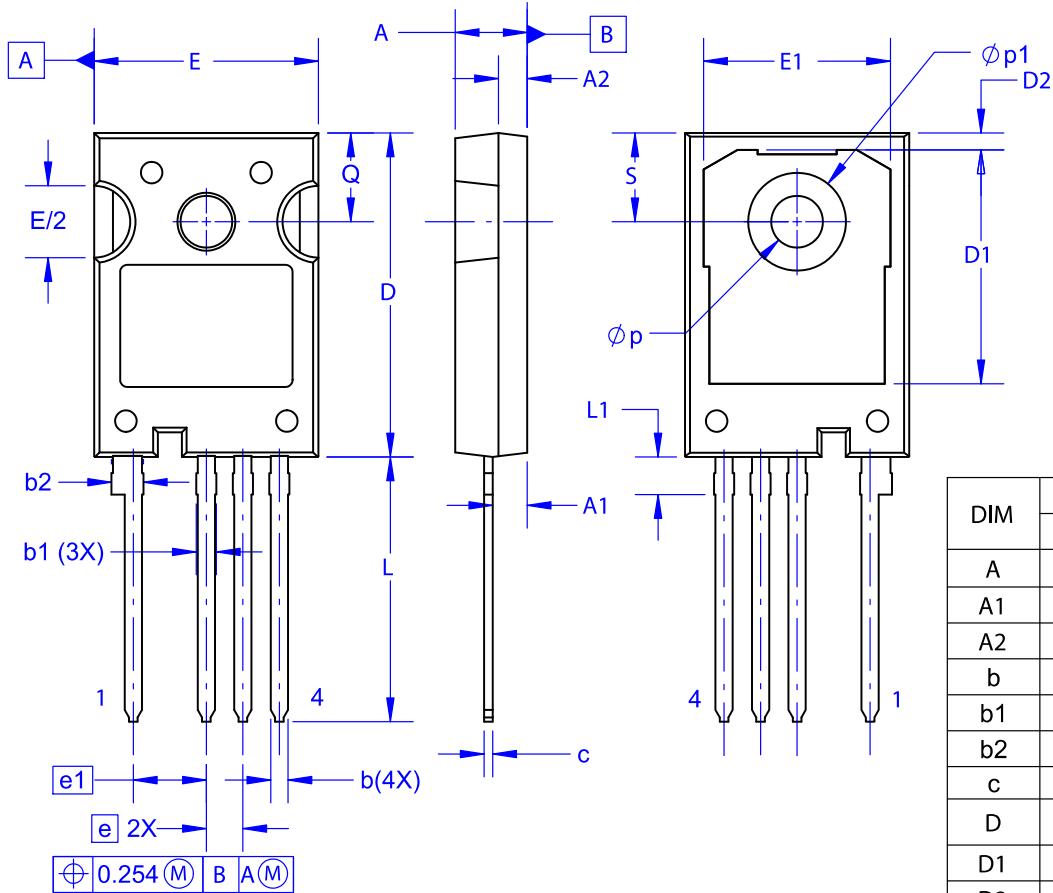


Figure 20. Peak Diode Recovery dv/dt Test Circuit & Waveforms

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**TO-247-4LD**  
**CASE 340CJ**  
**ISSUE A**



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- C. ALL DIMENSIONS ARE IN MILLIMETERS.
- D. DRAWING CONFORMS TO ASME Y14.5-2009.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.80	5.00	5.20
A1	2.10	2.40	2.70
A2	1.80	2.00	2.20
b	1.07	1.20	1.33
b1	1.20	1.40	1.60
b2	2.02	2.22	2.42
c	0.50	0.60	0.70
D	22.34	22.54	22.74
D1	16.00	16.25	16.50
D2	0.97	1.17	1.37
e	2.54 BSC		
e1	5.08 BSC		
E	15.40	15.60	15.80
E1	12.80	13.00	13.20
E/2	4.80	5.00	5.20
L	18.22	18.42	18.62
L1	2.42	2.62	2.82
p	3.40	3.60	3.80
p1	6.60	6.80	7.00
Q	5.97	6.17	6.37
S	5.97	6.17	6.37

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