

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

650 V, 58 A, 50 mΩ

NVHL050N65S3HF

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. $R_{DS(on)} = 41\text{ m}\Omega$
- Ultra Low Gate Charge (Typ. $Q_g = 119\text{ nC}$)
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)} = 1051\text{ pF}$)
- 100% Avalanche Tested
- AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

Applications

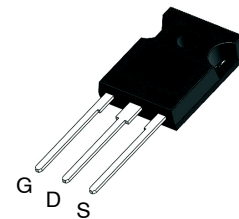
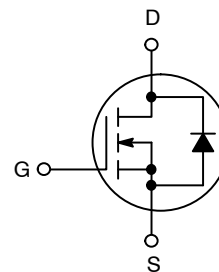
- Automotive On Board Charger HEV-EV
- Automotive DC/DC Converter HEV-EV



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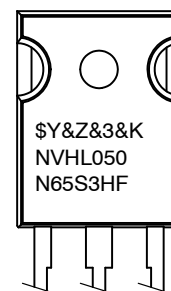
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V_{DS}	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
650 V	50 mΩ	58 A



**TO-247 long leads
CASE 340CX**

MARKING DIAGRAM



$\$Y$ = ON Semiconductor Logo
 $\&Z$ = Assembly Plant Code
 $\&3$ = Data Code (Year & Week)
 $\&K$ = Lot
 NVHL050N65S3HF = Specific Device Code

ORDERING INFORMATION

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

NVHL050N65S3HF

ABSOLUTE MAXIMUM RATINGS (T_C = 25°C, Unless otherwise noted)

Symbol	Parameter		Value	Unit
V _{DSS}	Drain to Source Voltage		650	V
V _{GSS}	Gate to Source Voltage	– DC	±30	V
		– AC (f > 1 Hz)	±30	
I _D	Drain Current	– Continuous (T _C = 25°C)	58	A
		– Continuous (T _C = 100°C)	36	
I _{DM}	Drain Current	– Pulsed (Note 1)	145	A
E _{AS}	Single Pulsed Avalanche Energy (Note 2)		830	mJ
I _{AS}	Avalanche Current (Note 2)		7.5	A
E _{AR}	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 _D	Power Dissipation	(T _C = 25°C)	403	W
		– Derate Above 25°C	3.23	W/°C
T _J , T _{STG}	Operating and Storage Temperature Range		–55 to +150	°C
T _L	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_{AS} = 7.5 A, R_G = 25 Ω, starting T_J = 25°C.

3. I_{SD} ≤ 29 A, di/dt ≤ 200 A/μs, V_{DD} ≤ 400 V, starting T_J = 25°C.

THERMAL CHARACTERISTICS

Symbol	Parameter	Value	Unit
R _{θJC}	Thermal Resistance, Junction to Case, Max.	0.31	°C/W
R _{θJA}	Thermal Resistance, Junction to Ambient, Max.	40	

PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Top Marking	Package	Packing Method	Reel Size	Tape Width	Quantity
NVHL050N65S3HF	NVHL050N65S3HF	TO-247	Tube	N/A	N/A	30 Units

NVHL050N65S3HF

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

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

BV _{DSS}	Drain to Source Breakdown Voltage	V _{GS} = 0 V, I _D = 1 mA, T _J = 25°C	650	–	–	V
		V _{GS} = 0 V, I _D = 1 mA, T _J = 150°C	700	–	–	V
ΔBV _{DSS} /ΔT _J	Breakdown Voltage Temperature Coefficient	I _D = 10 mA, Referenced to 25°C	–	0.64	–	V/°C
I _{DSS}	Zero Gate Voltage Drain Current	V _{DS} = 650 V, V _{GS} = 0 V	–	–	10	μA
		V _{DS} = 520 V, T _C = 125°C	–	22	–	
I _{GSS}	Gate to Body Leakage Current	V _{GS} = ±30 V, V _{DS} = 0 V	–	–	±100	nA

ON CHARACTERISTICS

V _{GS(th)}	Gate Threshold Voltage	V _{GS} = V _{DS} , I _D = 1.7 mA	3.0	–	5.0	V
R _{DS(on)}	Static Drain to Source On Resistance	V _{GS} = 10 V, I _D = 29 A	–	41	50	mΩ
g _{FS}	Forward Transconductance	V _{DS} = 20 V, I _D = 29 A	–	27	–	S

DYNAMIC CHARACTERISTICS

C _{iss}	Input Capacitance	V _{DS} = 400 V, V _{GS} = 0 V, f = 1 MHz	–	4880	–	pF
C _{oss}	Output Capacitance		–	113	–	pF
C _{oss(eff.)}	Effective Output Capacitance	V _{DS} = 0 V to 400 V, V _{GS} = 0 V	–	1051	–	pF
C _{oss(er.)}	Energy Related Output Capacitance	V _{DS} = 0 V to 400 V, V _{GS} = 0 V	–	200	–	pF
Q _{g(tot)}	Total Gate Charge at 10V	V _{DS} = 400 V, I _D = 29 A, V _{GS} = 10 V (Note 4)	–	119	–	nC
Q _{gs}	Gate to Source Gate Charge		–	36	–	nC
Q _{gd}	Gate to Drain “Miller” Charge		–	45	–	nC
ESR	Equivalent Series Resistance	f = 1 MHz	–	1.8	–	Ω

SWITCHING CHARACTERISTICS

t _{d(on)}	Turn-On Delay Time	V _{DD} = 400 V, I _D = 29 A, V _{GS} = 10 V, R _g = 2.2 Ω (Note 4)	–	32	–	ns
t _r	Turn-On Rise Time		–	30	–	ns
t _{d(off)}	Turn-Off Delay Time		–	89	–	ns
t _f	Turn-Off Fall Time		–	25	–	ns

SOURCE-DRAIN DIODE CHARACTERISTICS

I _S	Maximum Continuous Source to Drain Diode Forward Current		–	–	58	A
I _{SM}	Maximum Pulsed Source to Drain Diode Forward Current		–	–	145	A
V _{SD}	Source to Drain Diode Forward Voltage	V _{GS} = 0 V, I _{SD} = 29 A	–	–	1.3	V
t _{rr}	Reverse Recovery Time	V _{GS} = 0 V, I _{SD} = 29 A, dI _F /dt = 100 A/μs	–	128	–	ns
Q _{rr}	Reverse Recovery Charge		–	606	–	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

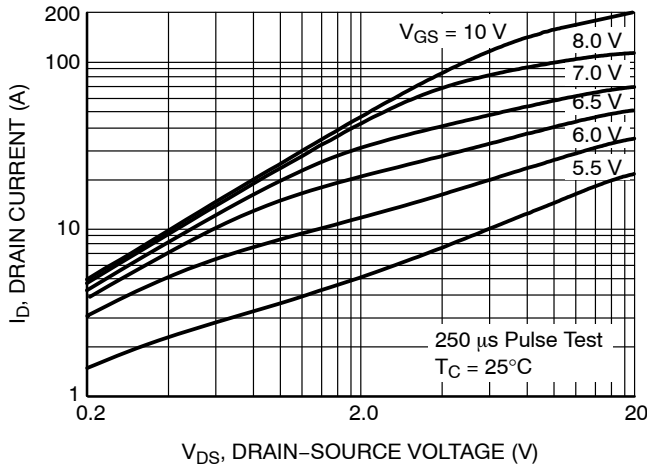


Figure 1. On-Region Characteristics

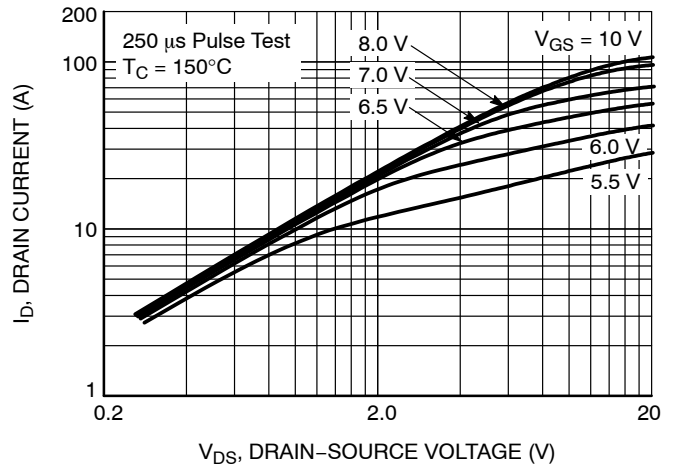


Figure 2. On-Region Characteristics

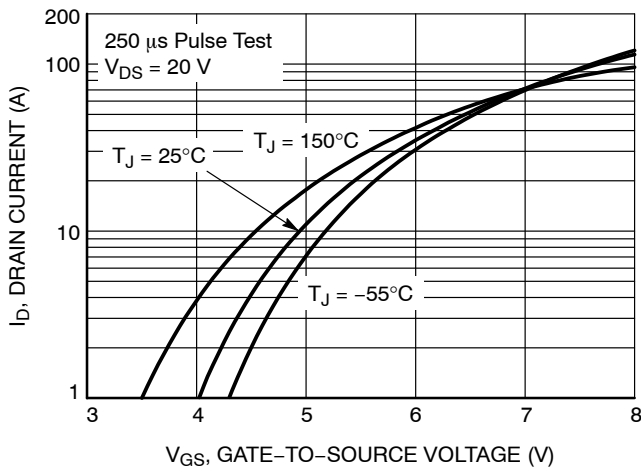


Figure 3. Transfer Characteristics

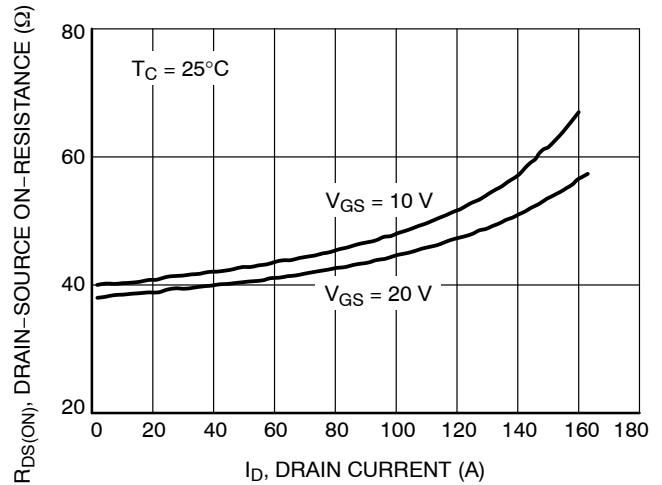


Figure 4. On-Resistance Variation vs. Drain Current and Gate Voltage

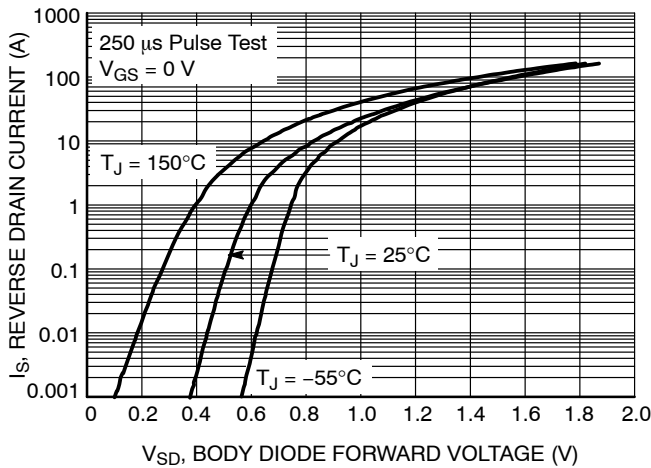


Figure 5. Body Diode Forward Voltage Variation vs. Source Current and Temperature

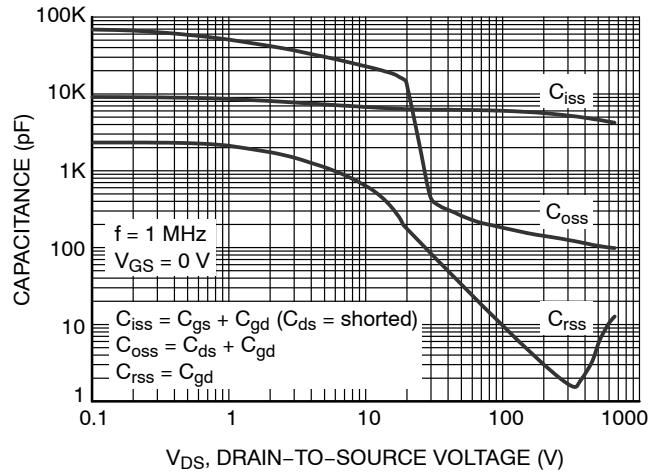


Figure 6. Capacitance Characteristics

TYPICAL CHARACTERISTICS

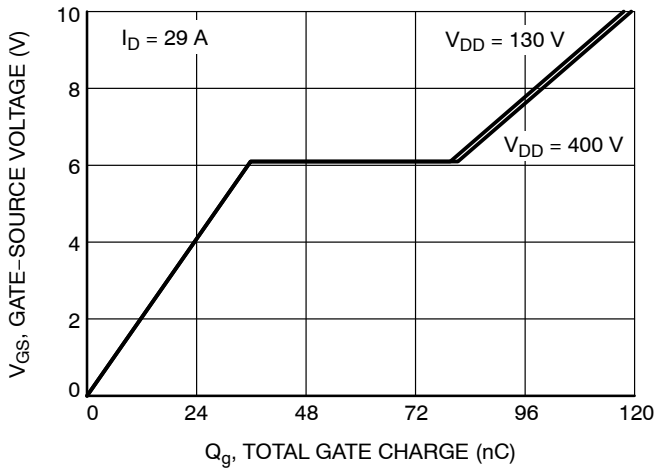


Figure 7. Gate Charge Characteristics

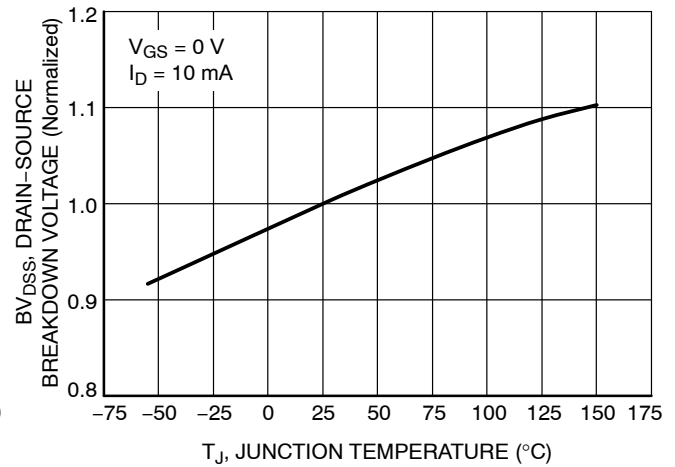


Figure 8. Breakdown Voltage Variation vs. Temperature

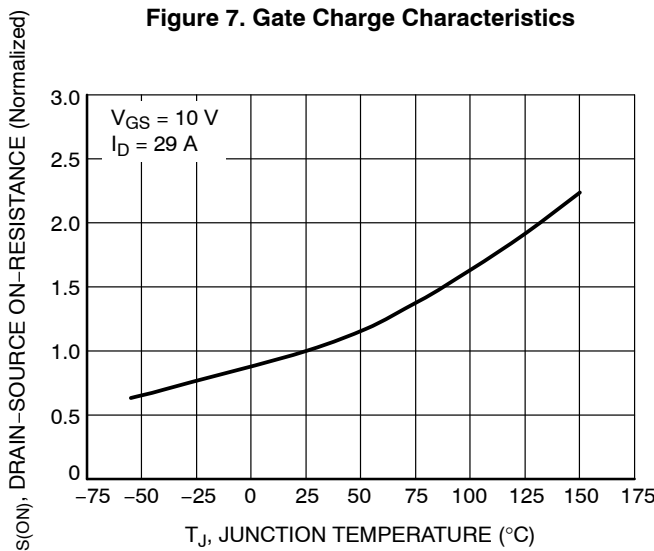


Figure 9. On-Resistance Variation vs. Temperature

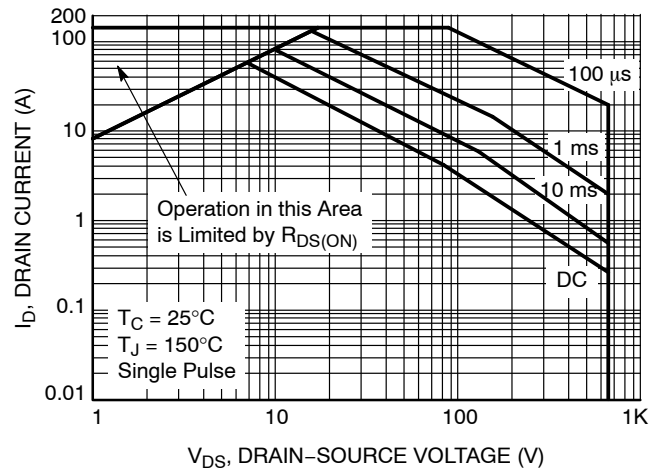


Figure 10. Maximum Safe Operating Area

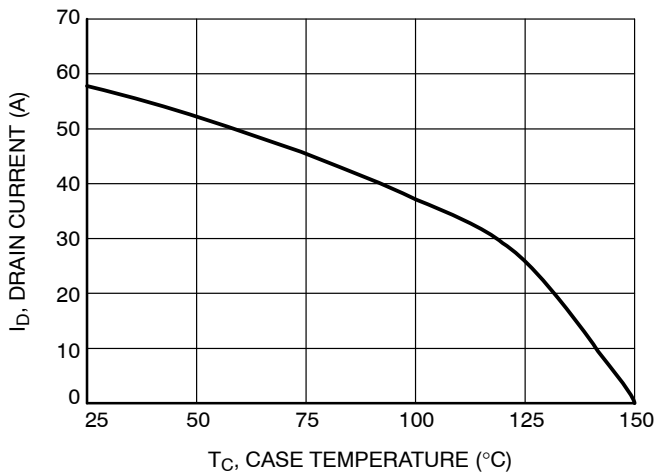


Figure 11. Maximum Drain Current vs. Case Temperature

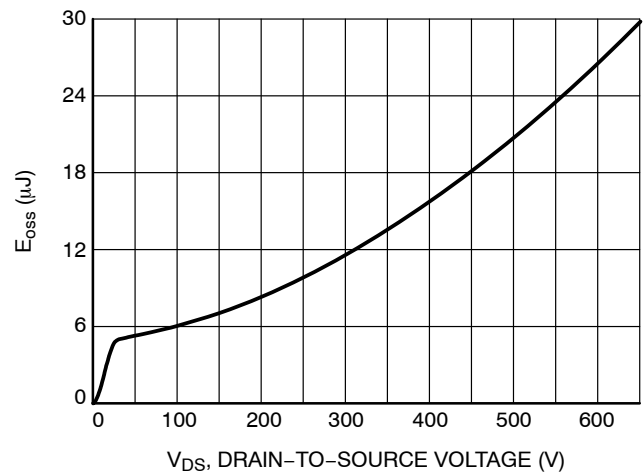


Figure 12. E_OSS vs. Drain-to-Source Voltage

TYPICAL CHARACTERISTICS

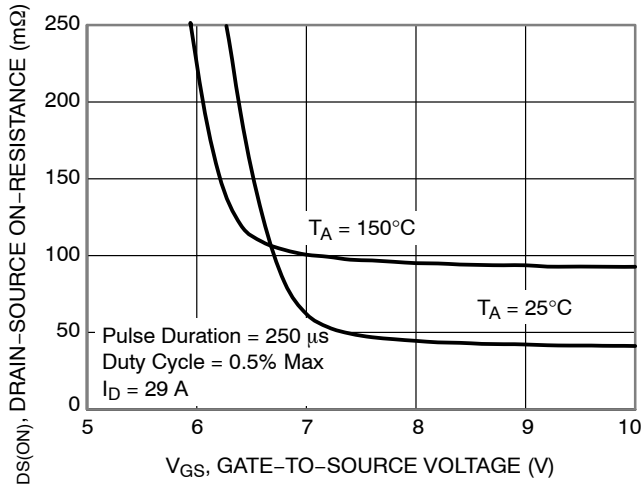


Figure 13. $R_{DS(ON)}$ vs. Gate Voltage

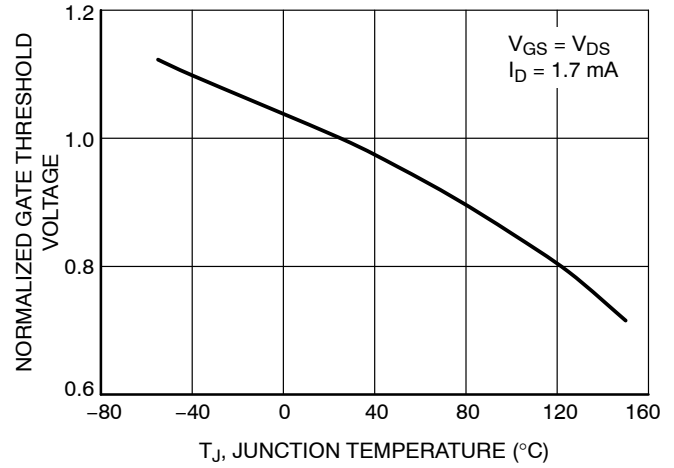


Figure 14. Normalized Gate Threshold Voltage vs. Temperature

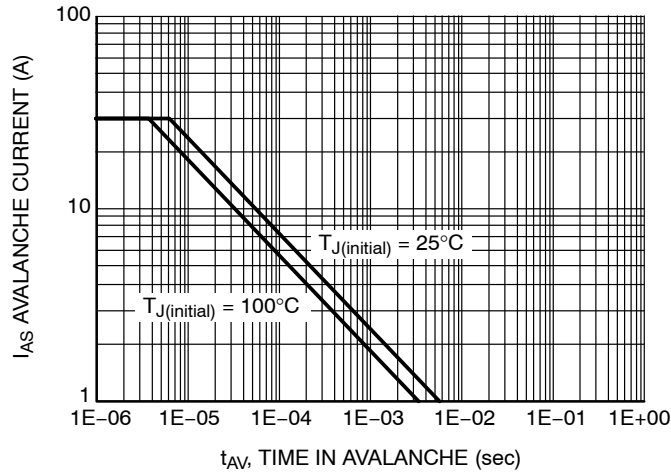


Figure 15. Unclamped Inductive Switching Capability

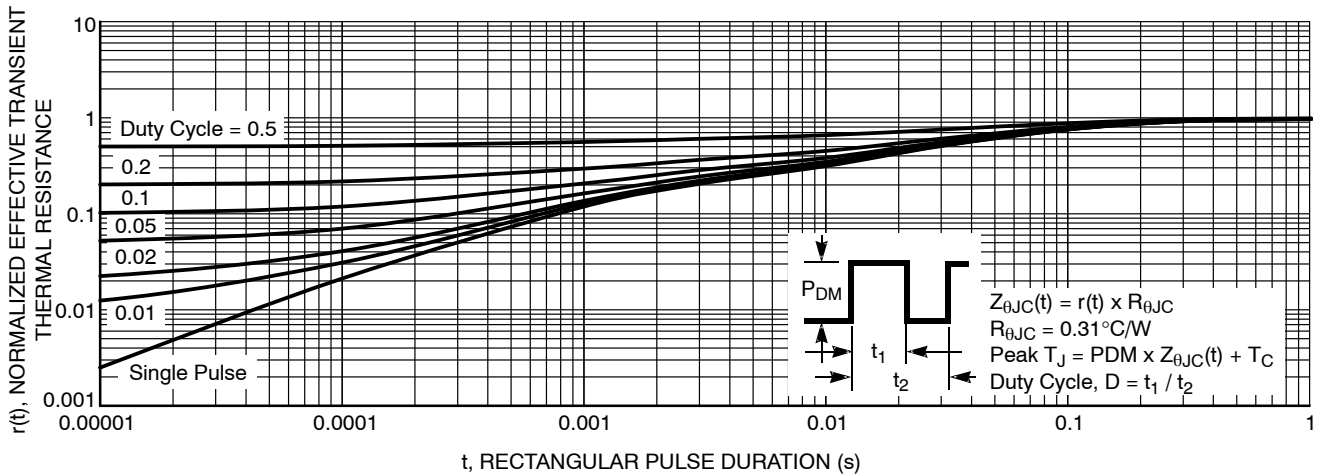


Figure 16. Transient Thermal Response Curve

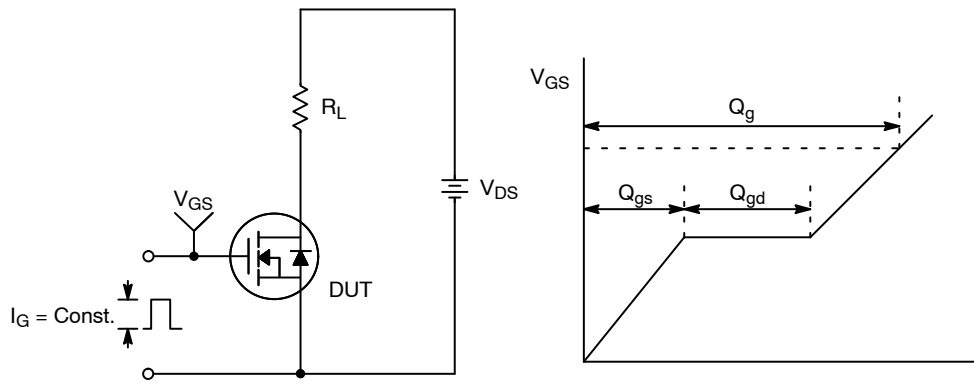


Figure 17. Gate Charge Test Circuit & Waveform

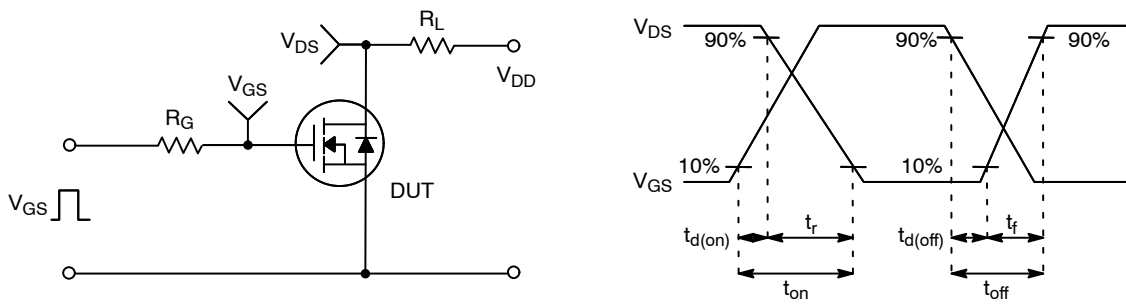


Figure 18. Resistive Switching Test Circuit & Waveforms

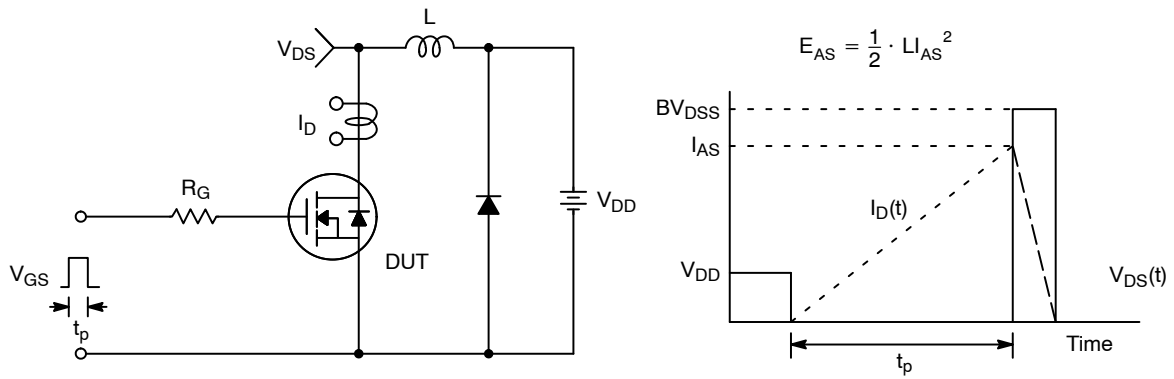


Figure 19. Unclamped Inductive Switching Test Circuit & Waveforms

Diagram illustrating a switching circuit for a Device Under Test (DUT) using a MOSFET driver.

The circuit includes the following components and connections:

- DUT (Device Under Test):** Represented by a circle containing a diode and a switch symbol. It is connected to a voltage source V_{SD} .
- Current I_{SD} :** Indicated by a downward arrow, representing the current through the DUT.
- Load Inductor L :** Connected in series with the DUT output.
- Driver MOSFET:** Labeled "Driver", it is a MOSFET of the same type as the DUT. Its gate is driven by a pulse voltage V_{GS} through a gate resistor R_G .
- Supply Voltage V_{DD} :** Provides the main power supply for the driver and the load.

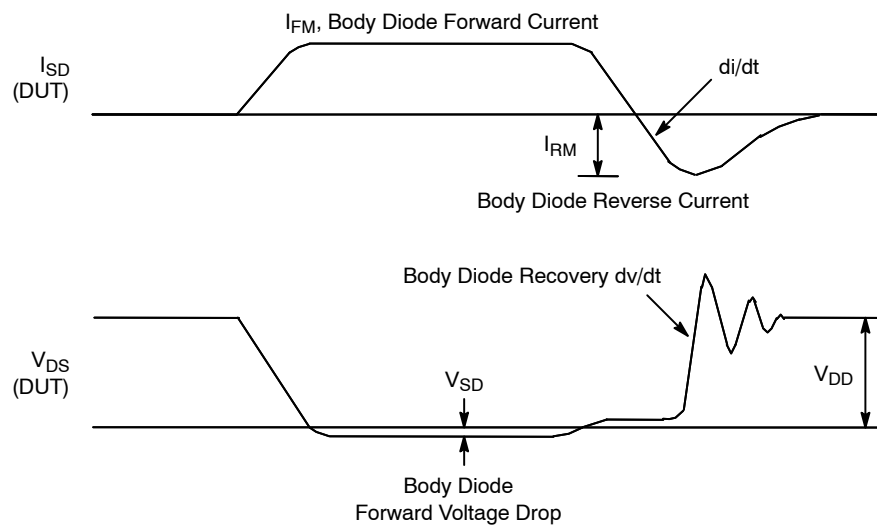
Key characteristics of the circuit:

- dv/dt is controlled by R_G .
- I_{SD} is controlled by the pulse period.

$D = \frac{\text{Gate Pulse Width}}{\text{Gate Pulse Period}}$

V_{GS} (Driver)

10 V



8

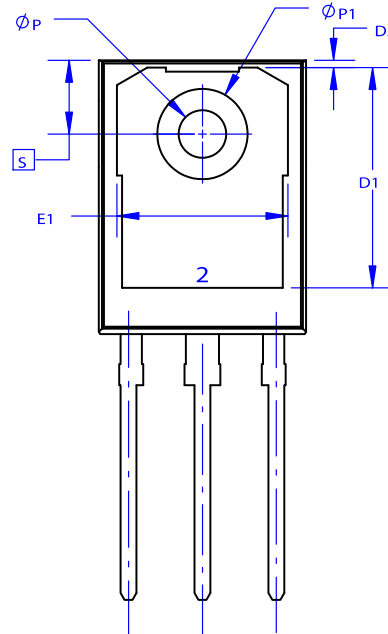
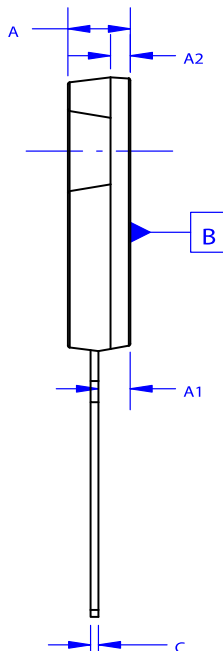
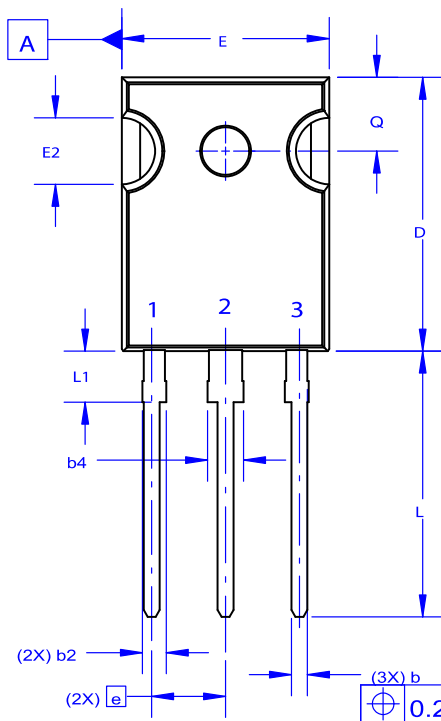
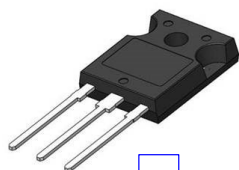
MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

ON Semiconductor®



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.

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.

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

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