

# MOSFET – Power, N-Channel, SUPERFET<sup>®</sup> V, Easy Drive 600 V, 99 mΩ, 33 A



ON Semiconductor<sup>®</sup>

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

## NTHL099N60S5

### Description

The SUPERFET V MOSFET is the fifth generation high voltage super-junction (SJ) MOSFET family from ON Semiconductor. SUPERFET V delivers best-in-class FOMs ( $R_{DS(ON)} \cdot Q_G$  and  $R_{DS(ON)} \cdot E_{OSS}$ ) to improve not only heavy load but also light load efficiency. The 600 V SUPERFET V series provides design benefits through reduced conduction and switching losses, while supporting extreme MOSFET  $dV_{DS}/dt$  ratings at 120 V/ns and high body diode  $dV_{DS}/dt$  ratings at 50 V/ns. Consequently, the SUPERFET V MOSFET Easy Drive series combine excellent switching performance without sacrificing ease of use for both hard and soft switching topologies. It helps manage EMI issues and allows for easier design implementation with excellent system efficiency.

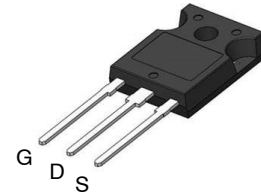
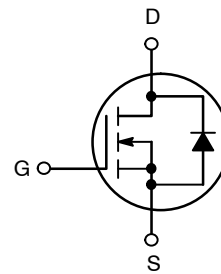
### Features

- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 79.2 \text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 48 \text{ nC}$ )
- Low Time Related Output Capacitance (Typ.  $C_{oss(tr.)} = 642 \text{ pF}$ )
- 100% Avalanche Tested
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

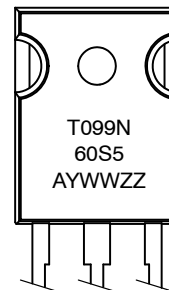
- Telecom / Server Power Supplies
- Industrial Power Supplies
- EV Charger
- UPS / Solar

$V_{DSS}$	$R_{DS(ON)} \text{ MAX}$	$I_D \text{ MAX}$
600 V	99 mΩ @ 10 V	33 A



TO-247 Long Leads  
CASE 340CX

### MARKING DIAGRAM



T099N60S5 = Specific Device Code  
A = Assembly Plant Code  
YWW = Date Code (Year & Week)  
ZZ = Lot

### ORDERING INFORMATION

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

# NTHL099N60S5

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

Symbol	Parameter	Value	Unit
V <sub>DSS</sub>	Drain to Source Voltage	600	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)	33*
		- Continuous (T <sub>C</sub> = 100°C)	20*
I <sub>DM</sub>	Drain Current	- Pulsed (Note 1)	95*
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)	232	mJ
I <sub>AS</sub>	Avalanche Current (Note 2)	5.1	A
E <sub>AR</sub>	Repetitive Avalanche Energy (Note 1)	1.84	mJ
dv/dt	MOSFET dv/dt	120	V/ns
	Peak Diode Recovery dv/dt (Note 3)	50	
P <sub>D</sub>	Power Dissipation	(T <sub>C</sub> = 25°C)	184
		- Derate Above 25°C	1.47
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	260	°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.

\*Drain current limited by maximum junction temperature.

1. Repetitive rating; pulse-width limited by maximum junction temperature.
2. I<sub>AS</sub> = 5.1 A, R<sub>G</sub> = 25 Ω, starting T<sub>J</sub> = 25°C.
3. I<sub>SD</sub> ≤ 13.5 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.	0.68	°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
NTHL099N60S5	T099N60S5	TO-247	Tube	N/A	N/A	30 Units

# NTHL099N60S5

## 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	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 25^\circ\text{C}$	600	–	–	V
		$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 150^\circ\text{C}$	650	–	–	V
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D = 10\text{ mA}$ , Referenced to $25^\circ\text{C}$	–	0.63	–	V/ $^\circ\text{C}$
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	$V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$	–	–	1	$\mu\text{A}$
		$V_{DS} = 480\text{ V}, T_C = 125^\circ\text{C}$	–	1	–	
I <sub>GSS</sub>	Gate to Body Leakage Current	$V_{GS} = \pm 30\text{ V}, V_{DS} = 0\text{ V}$	–	–	$\pm 100$	nA

### ON CHARACTERISTICS

V <sub>GS(th)</sub>	Gate Threshold Voltage	$V_{GS} = V_{DS}, I_D = 2.8\text{ mA}$	2.4	–	4.0	V
R <sub>DS(on)</sub>	Static Drain to Source On Resistance	$V_{GS} = 10\text{ V}, I_D = 13.5\text{ A}$	–	79.2	99	m $\Omega$
g <sub>FS</sub>	Forward Transconductance	$V_{DS} = 20\text{ V}, I_D = 13.5\text{ A}$	–	26	–	S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	$V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, f = 250\text{ kHz}$	–	2500	–	pF
C <sub>oss</sub>	Output Capacitance		–	41	–	pF
C <sub>oss(tr.)</sub>	Time Related Output Capacitance	$I_D = \text{constant}, V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$	–	642	–	pF
C <sub>oss(er.)</sub>	Energy Related Output Capacitance	$V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$	–	70	–	pF
Q <sub>g(tot)</sub>	Total Gate Charge	$V_{DD} = 400\text{ V}, I_D = 13.5\text{ A}, V_{GS} = 10\text{ V}$	–	48	–	nC
Q <sub>gs</sub>	Gate to Source Charge		–	12	–	nC
Q <sub>gd</sub>	Gate to Drain Charge		–	14	–	nC
ESR	Equivalent Series Resistance		$f = 1\text{ MHz}$	–	6.9	–

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	$V_{DD} = 400\text{ V}, I_D = 13.5\text{ A}, V_{GS} = 10\text{ V}, R_g = 4.7\text{ }\Omega$	–	26	–	ns
t <sub>r</sub>	Turn-On Rise Time		–	17	–	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		–	92	–	ns
t <sub>f</sub>	Turn-Off Fall Time		–	4.2	–	ns

### SOURCE-DRAIN DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Source to Drain Diode Forward Current	–	–	33	A	
I <sub>SM</sub>	Maximum Pulsed Source to Drain Diode Forward Current	–	–	95	A	
V <sub>SD</sub>	Source to Drain Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_{SD} = 13.5\text{ A}$	–	–	1.2	V
t <sub>rr</sub>	Reverse Recovery Time	$V_{DD} = 400\text{ V}, I_{SD} = 13.5\text{ A}, di_F/dt = 100\text{ A}/\mu\text{s}$	–	310	–	ns
Q <sub>rr</sub>	Reverse Recovery Charge		–	4.6	–	$\mu\text{C}$

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.

TYPICAL CHARACTERISTICS

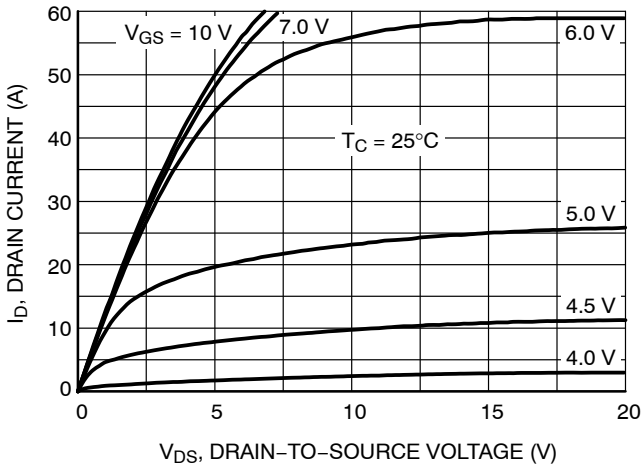


Figure 1. On-Region Characteristics

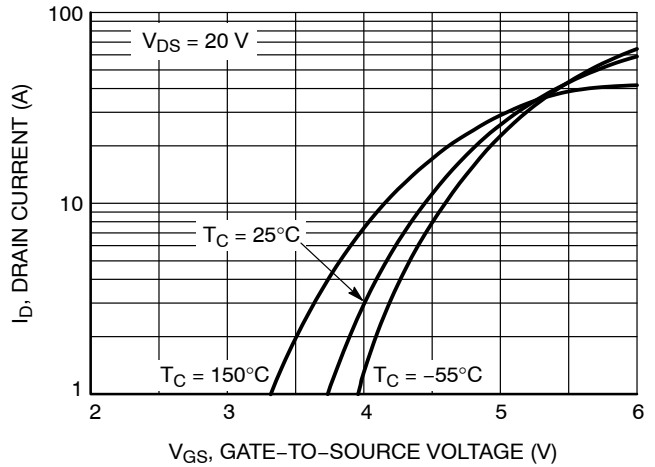


Figure 2. Transfer Characteristics

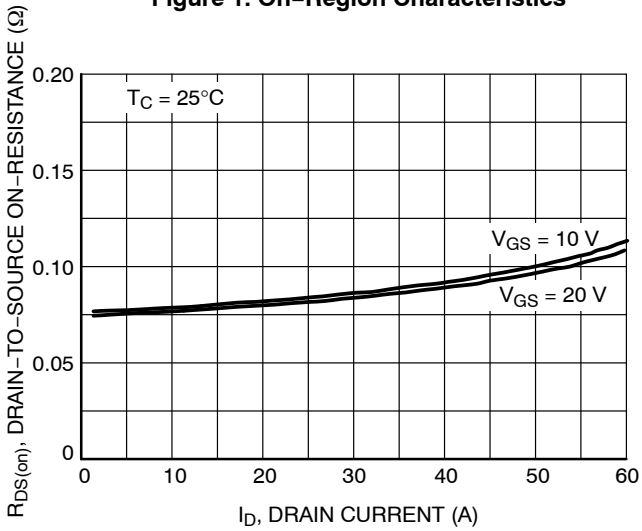


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

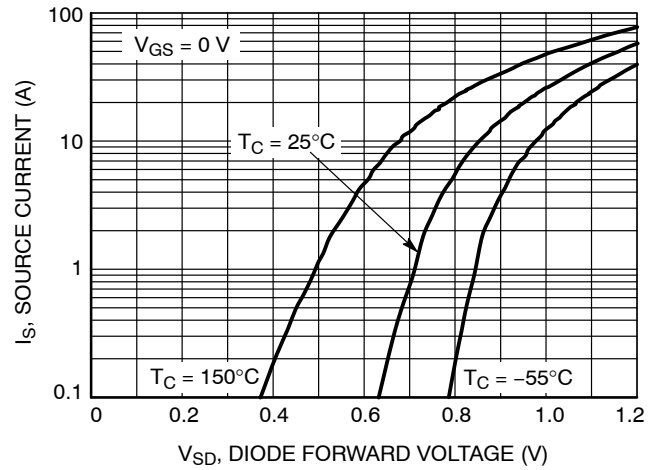


Figure 4. Diode Forward Voltage vs. Source Current

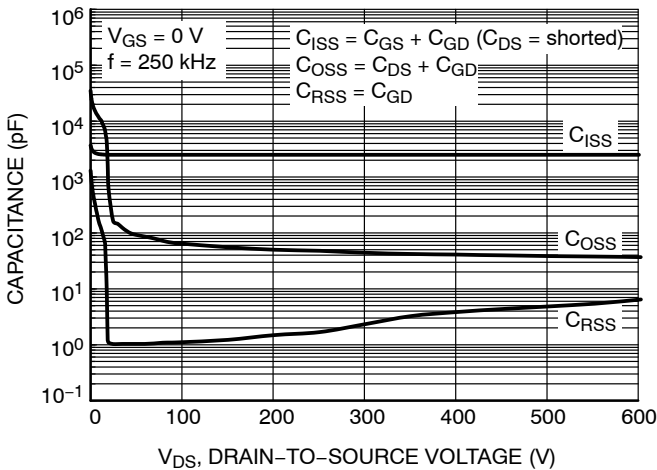


Figure 5. Capacitance Characteristics

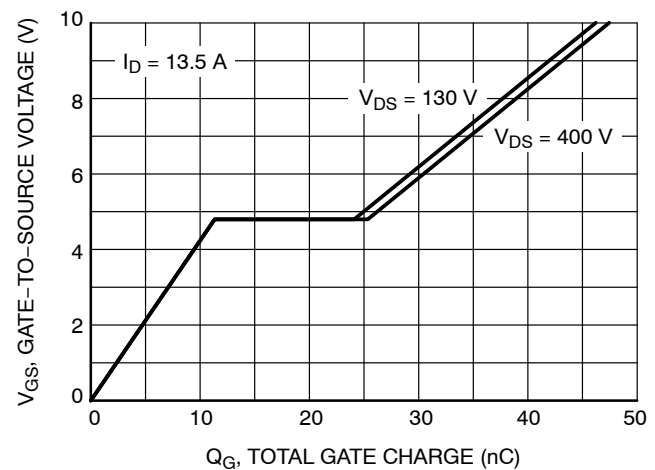


Figure 6. Gate Charge Characteristics

TYPICAL CHARACTERISTICS

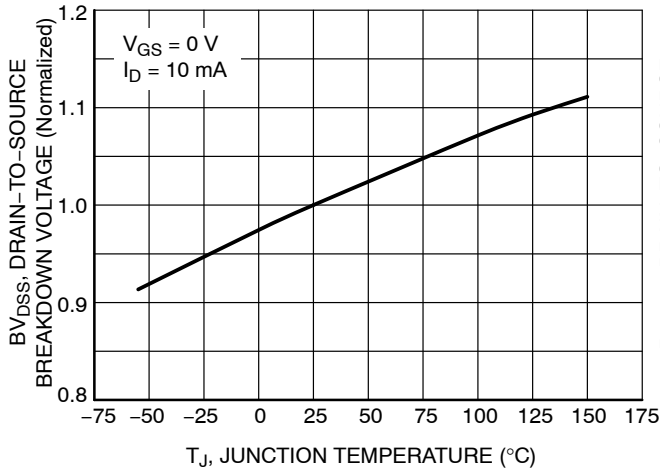


Figure 7. Breakdown Voltage Variation vs. Temperature

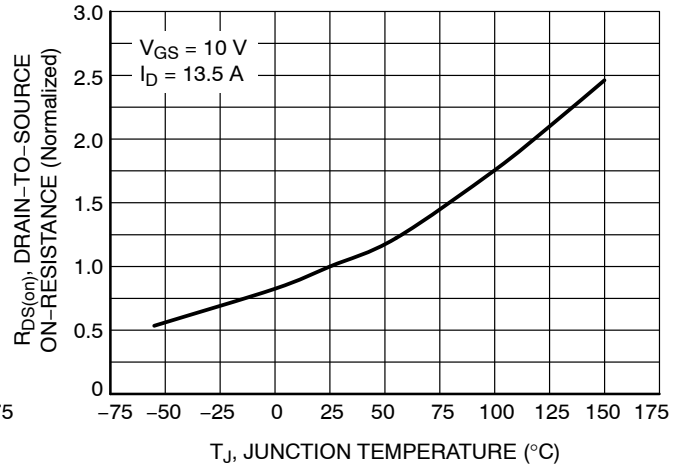


Figure 8. On-Resistance Variation vs. Temperature

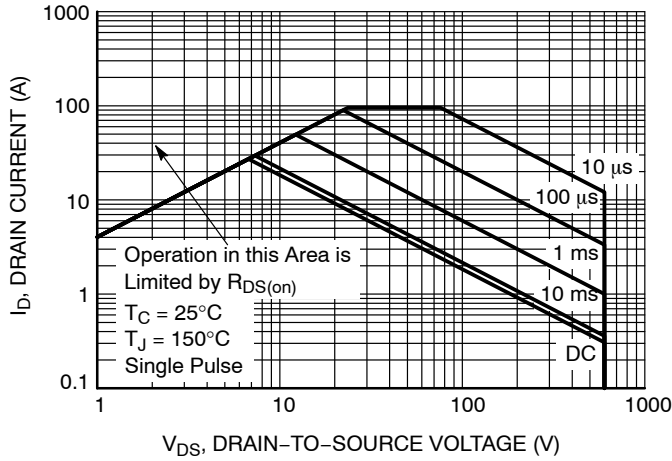


Figure 9. Maximum Safe Operating Area

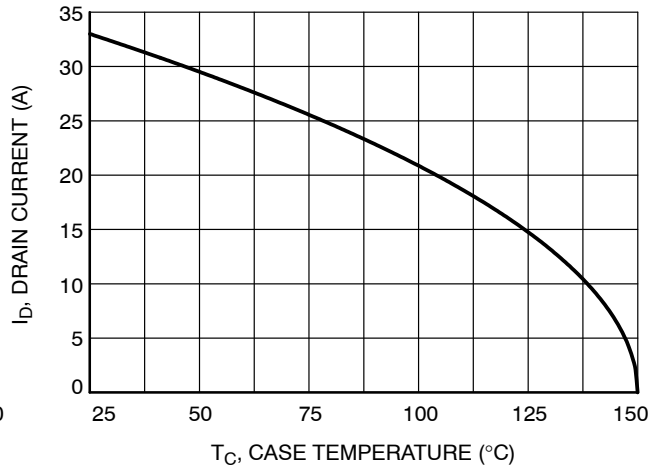


Figure 10. Maximum Drain Current vs. Case Temperature

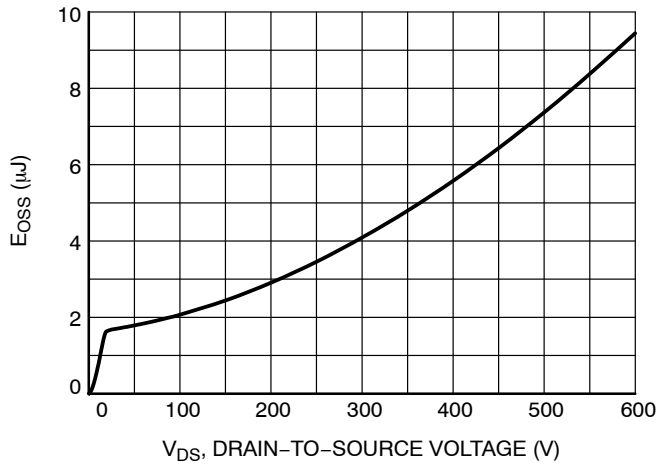


Figure 11.  $E_{OSS}$  vs. Drain-to-Source Voltage

TYPICAL CHARACTERISTICS

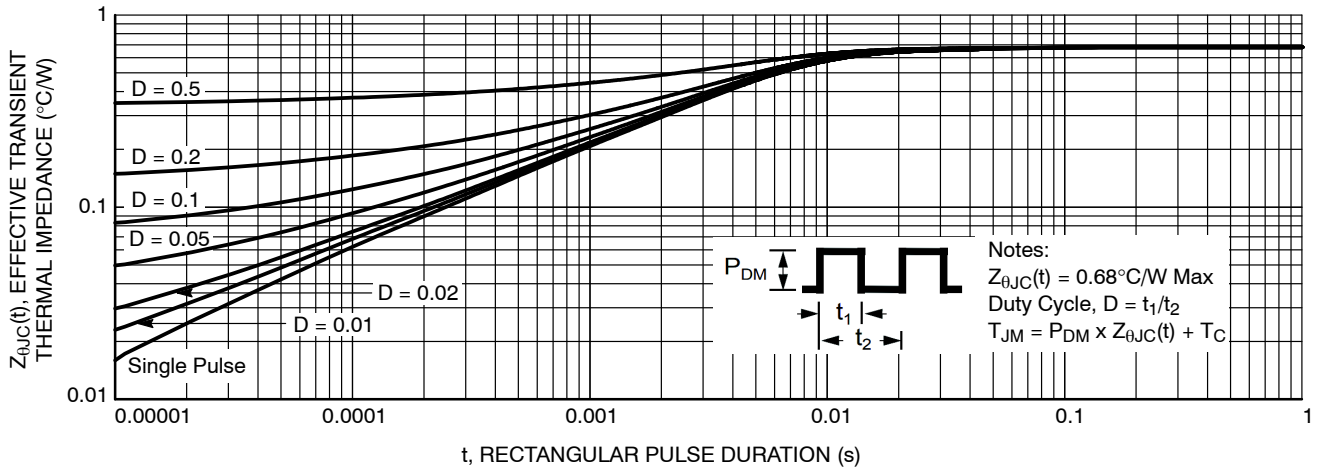


Figure 12. Transient Thermal Impedance

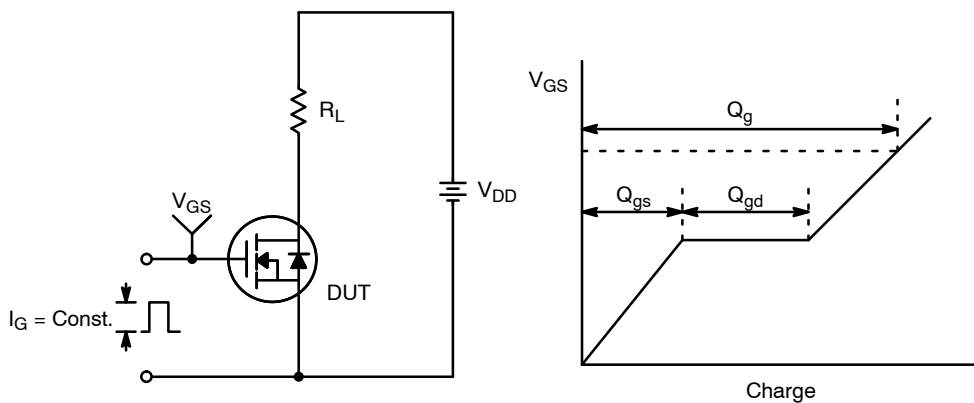


Figure 13. Gate Charge Test Circuit & Waveform

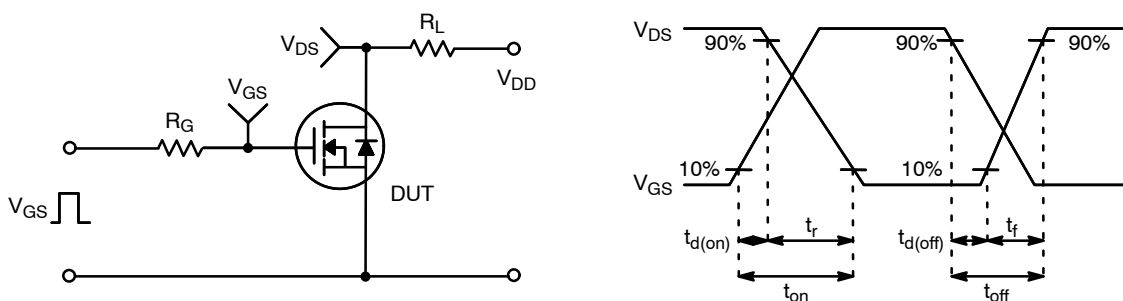


Figure 14. Resistive Switching Test Circuit & Waveforms

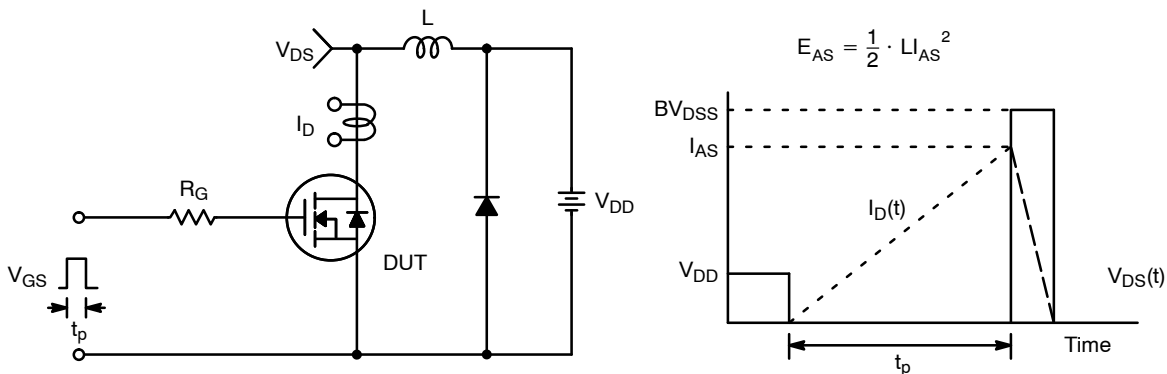
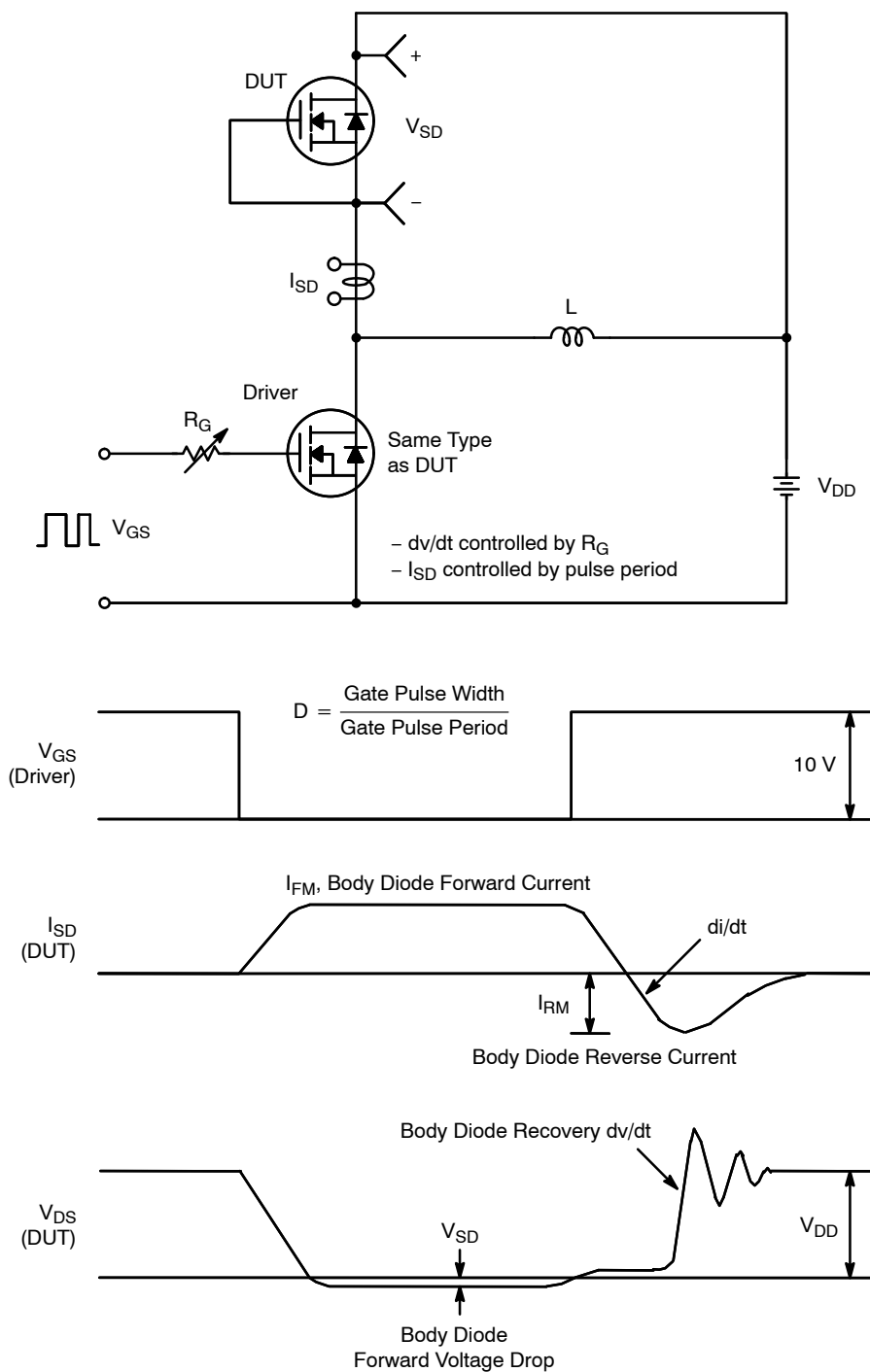



Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

# NTHL099N60S5



**Figure 16. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**



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