

# MOSFET – Power, N-Channel, SUPERFET® V, FAST

600 V, 41 mΩ, 57 A



ON Semiconductor®

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

## NTHL041N60S5H

### 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 SUPERET V series provides design benefits through reduced conduction and switching losses, while supporting extreme MOSFET  $dV_{DS}/dt$  ratings at 120 V/ns. Consequently, the SUPERFET V MOSFET FAST series helps maximize system efficiency and power density.

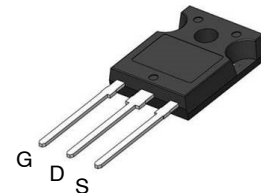
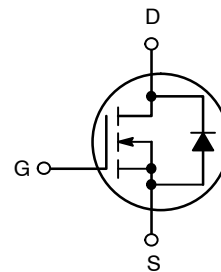
### Features

- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 32.8\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 108\text{ nC}$ )
- Low Time Related Output Capacitance (Typ.  $C_{oss(tr.)} = 1451\text{ pF}$ )
- 100% Avalanche Tested
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

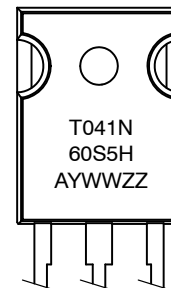
- Telecom / Server Power Supplies
- Industrial Power Supplies
- EV Charger
- UPS / Solar

$V_{DSS}$	$R_{DS(ON)}\text{ MAX}$	$I_D\text{ MAX}$
600 V	41 mΩ @ 10 V	57 A



TO-247 Long Leads  
CASE 340CX

### MARKING DIAGRAM



T041N60S5H = Specific Device Code  
 A = Assembly Plant Code  
 YWW = Data Code (Year & Week)  
 ZZ = Lot

### ORDERING INFORMATION

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

# NTHL041N60S5H

## 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)	57
		- Continuous (T <sub>C</sub> = 100°C)	36
I <sub>DM</sub>	Drain Current	- Pulsed (Note 1)	200
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)	560	mJ
I <sub>AS</sub>	Avalanche Current (Note 2)	8	A
E <sub>AR</sub>	Repetitive Avalanche Energy (Note 1)	3.29	mJ
dv/dt	MOSFET dv/dt	120	V/ns
	Peak Diode Recovery dv/dt (Note 3)	20	
P <sub>D</sub>	Power Dissipation	(T <sub>C</sub> = 25°C)	329
		- Derate Above 25°C	2.63
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.

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2. I<sub>AS</sub> = 8 A, R<sub>G</sub> = 25 Ω, starting T<sub>J</sub> = 25°C.
3. I<sub>SD</sub> ≤ 28.5 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.	0.38	°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
NTHL041N60S5H	T041N60S5H	TO-247	Tube	N/A	N/A	30 Units

# NTHL041N60S5H

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°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	600	-	-	V
		V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA, T <sub>J</sub> = 150°C	650	-	-	V
ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	Breakdown Voltage Temperature Coefficient	I <sub>D</sub> = 10 mA, Referenced to 25°C	-	0.63	-	V/°C
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V	-	-	2	μA
		V <sub>DS</sub> = 480 V, T <sub>C</sub> = 125°C	-	2.9	-	
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> = 6.7 mA	2.7	-	4.3	V
R <sub>DS(on)</sub>	Static Drain to Source On Resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 28.5 A	-	32.8	41	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 28.5 A	-	66	-	S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 250 kHz	-	5840	-	pF
C <sub>oss</sub>	Output Capacitance		-	92	-	pF
C <sub>oss(tr.)</sub>	Time Related Output Capacitance	I <sub>D</sub> = Constant, V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V	-	1451	-	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	-	155	-	pF
Q <sub>g(tot)</sub>	Total Gate Charge	V <sub>DD</sub> = 400 V, I <sub>D</sub> = 28.5 A, V <sub>GS</sub> = 10 V	-	108	-	nC
Q <sub>gs</sub>	Gate to Source Charge		-	28	-	nC
Q <sub>gd</sub>	Gate to Drain Charge		-	29	-	nC
ESR	Equivalent Series Resistance	f = 1 MHz	-	0.6	-	Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 400 V, I <sub>D</sub> = 28.5 A, V <sub>GS</sub> = 10 V, R <sub>g</sub> = 2.2 Ω	-	33	-	ns
t <sub>r</sub>	Turn-On Rise Time		-	11	-	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		-	81	-	ns
t <sub>f</sub>	Turn-Off Fall Time		-	2	-	ns

### SOURCE-DRAIN DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Source to Drain Diode Forward Current	-	-	57	A	
I <sub>SM</sub>	Maximum Pulsed Source to Drain Diode Forward Current	-	-	200	A	
V <sub>SD</sub>	Source to Drain Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 28.5 A	-	-	1.2	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>DD</sub> = 400 V, I <sub>SD</sub> = 28.5 A, dI <sub>F</sub> /dt = 100 A/μs	-	461	-	ns
Q <sub>rr</sub>	Reverse Recovery Charge		-	9.6	-	μC

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.

# NTHL041N60S5H

## TYPICAL CHARACTERISTICS

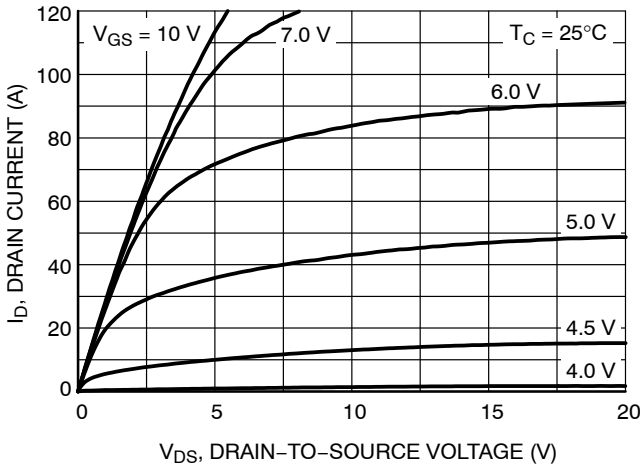


Figure 1. On-Region Characteristics

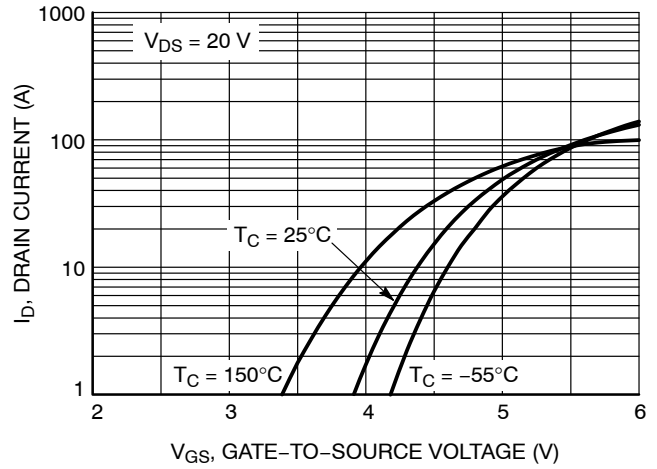


Figure 2. Transfer Characteristics

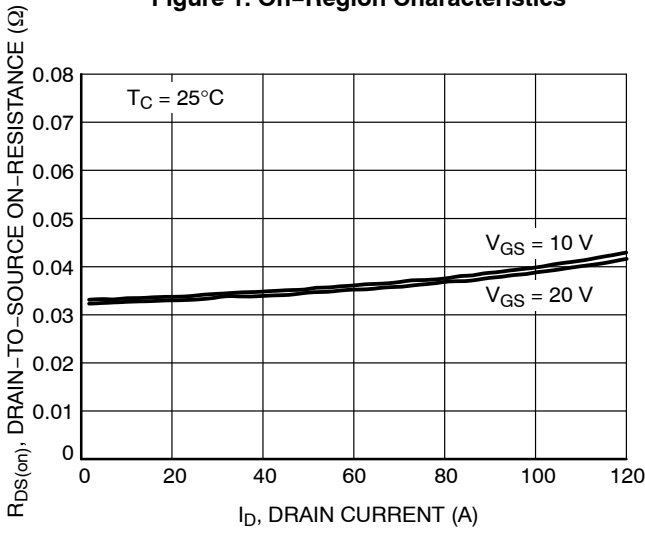


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

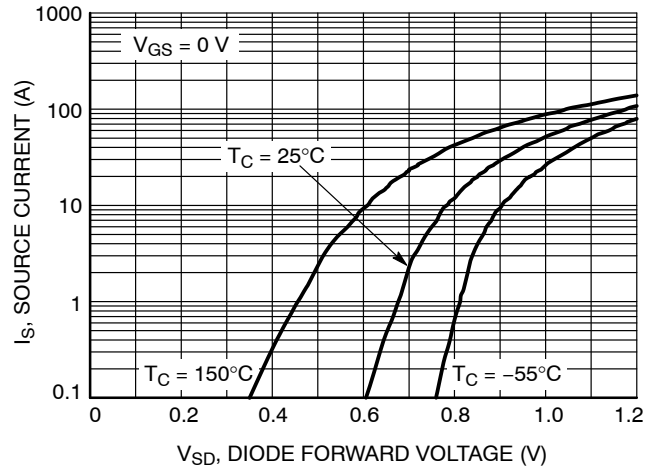


Figure 4. Diode Forward Voltage vs. Source Current

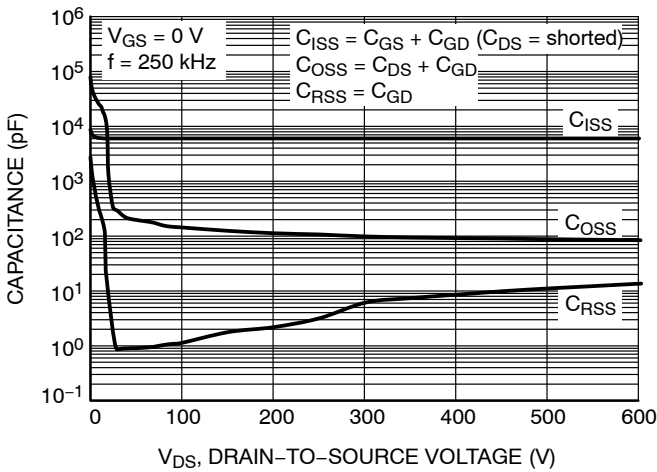


Figure 5. Capacitance Characteristics

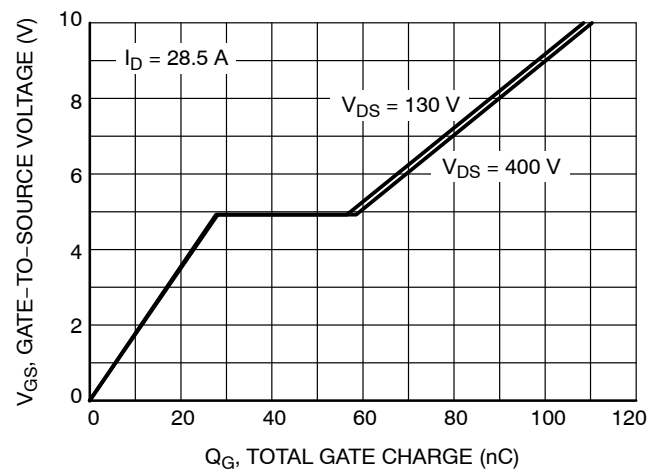
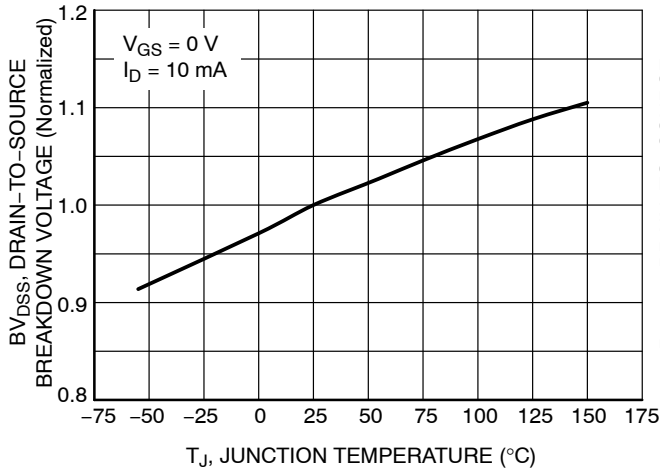


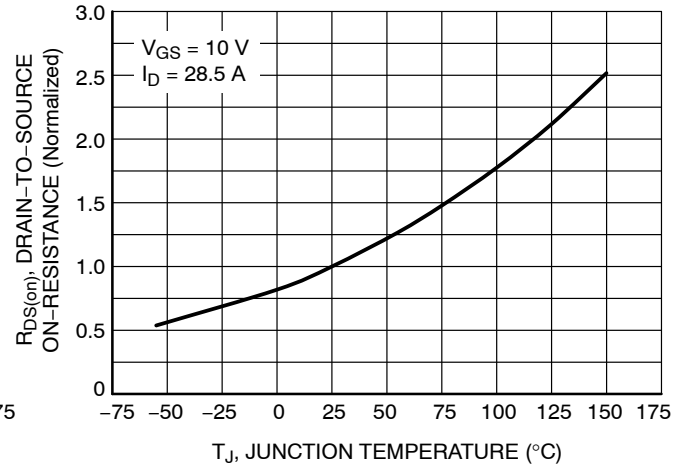
Figure 6. Gate Charge Characteristics

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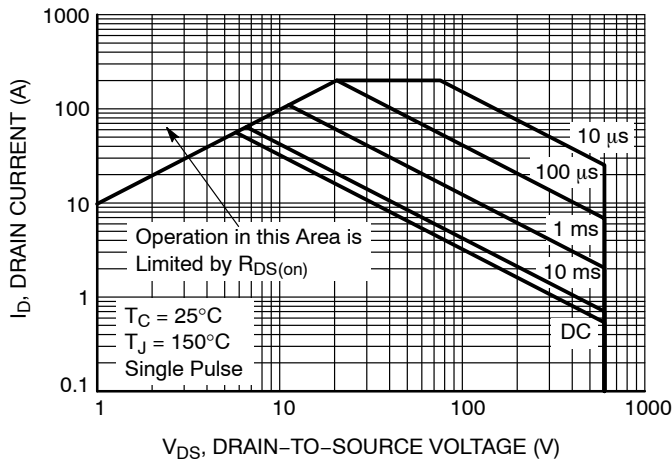
## TYPICAL CHARACTERISTICS



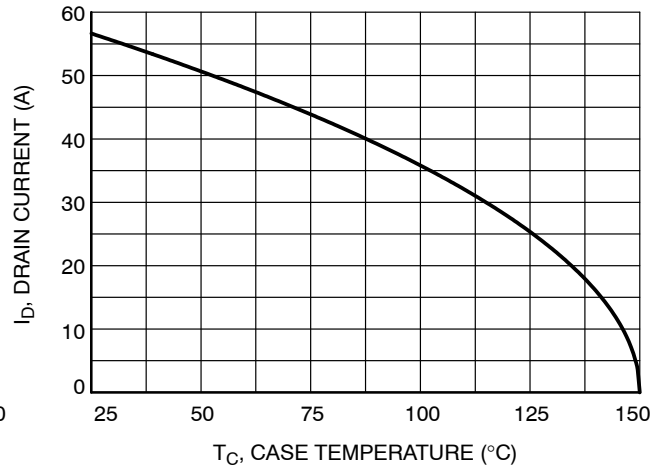
**Figure 7. Breakdown Voltage Variation vs. Temperature**



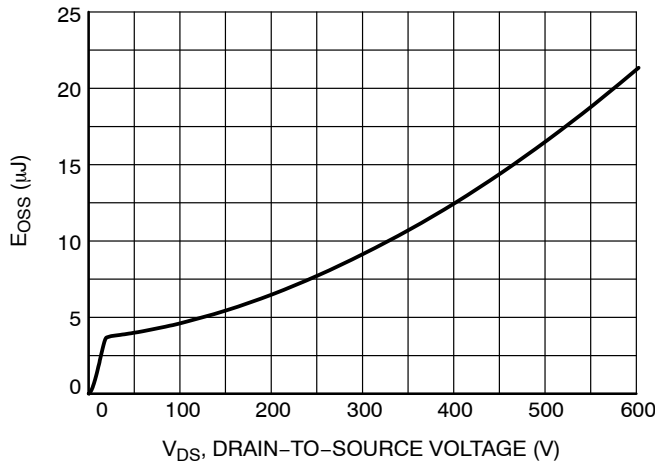
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**



**Figure 10. Maximum Drain Current vs. Case Temperature**



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

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## TYPICAL CHARACTERISTICS

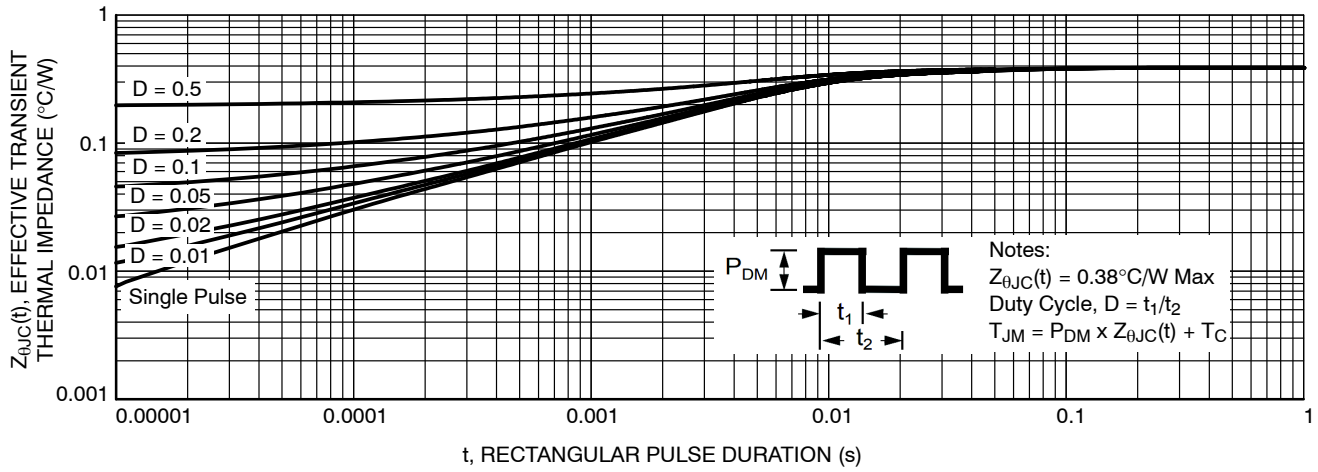


Figure 12. Transient Thermal Impedance

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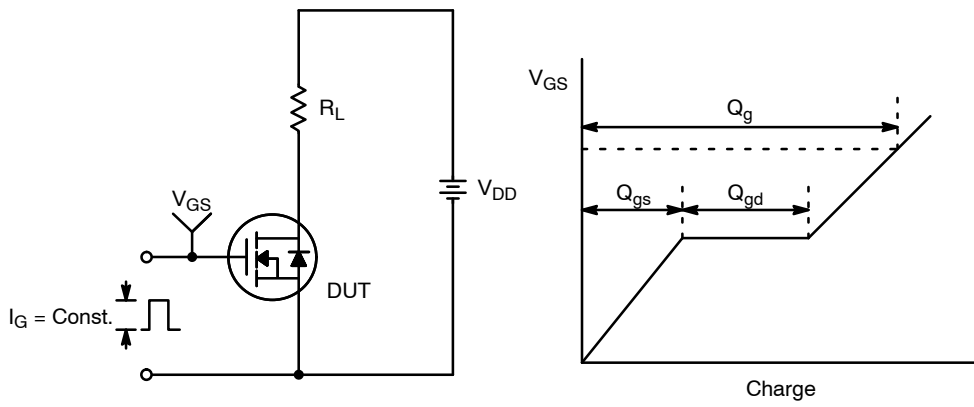


Figure 13. Gate Charge Test Circuit & Waveform

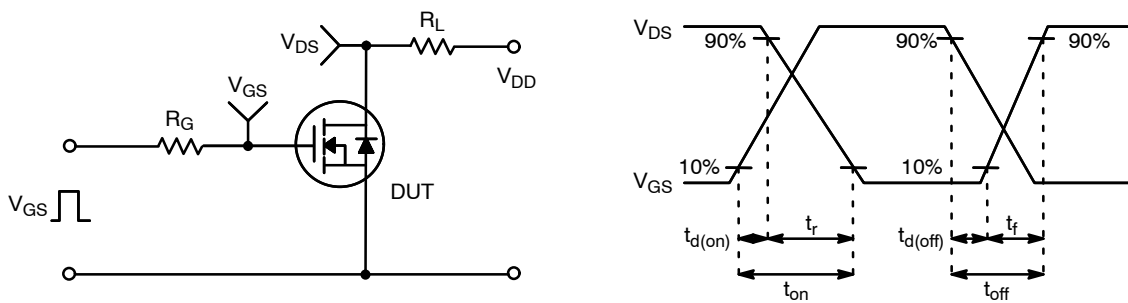


Figure 14. Resistive Switching Test Circuit & Waveforms

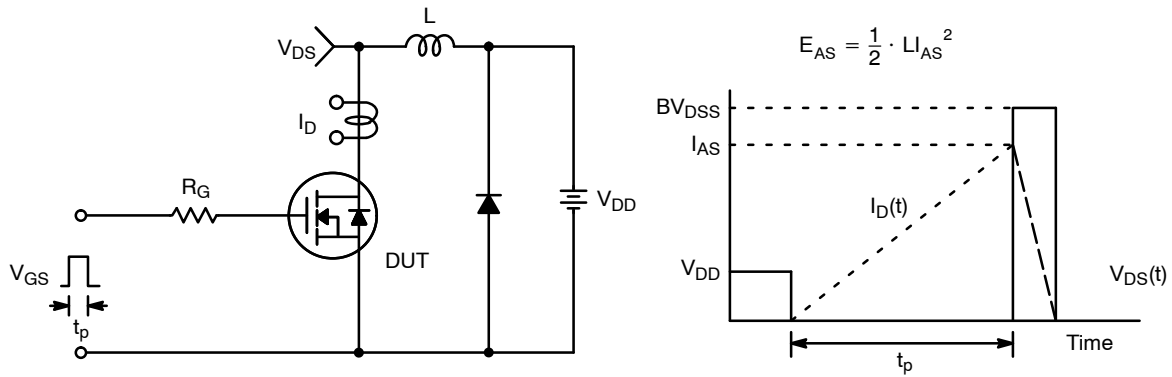
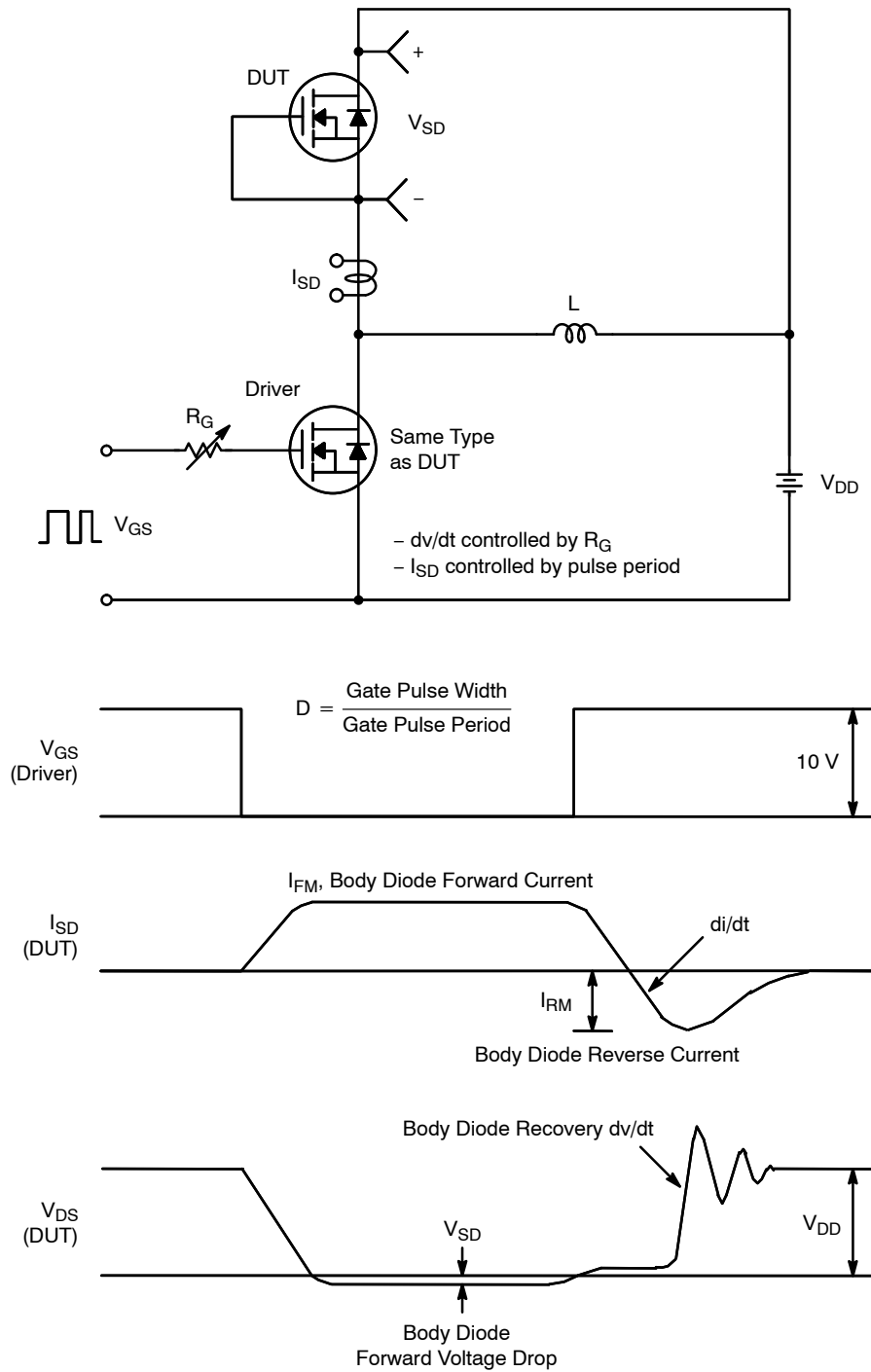


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

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



# MECHANICAL CASE OUTLINE

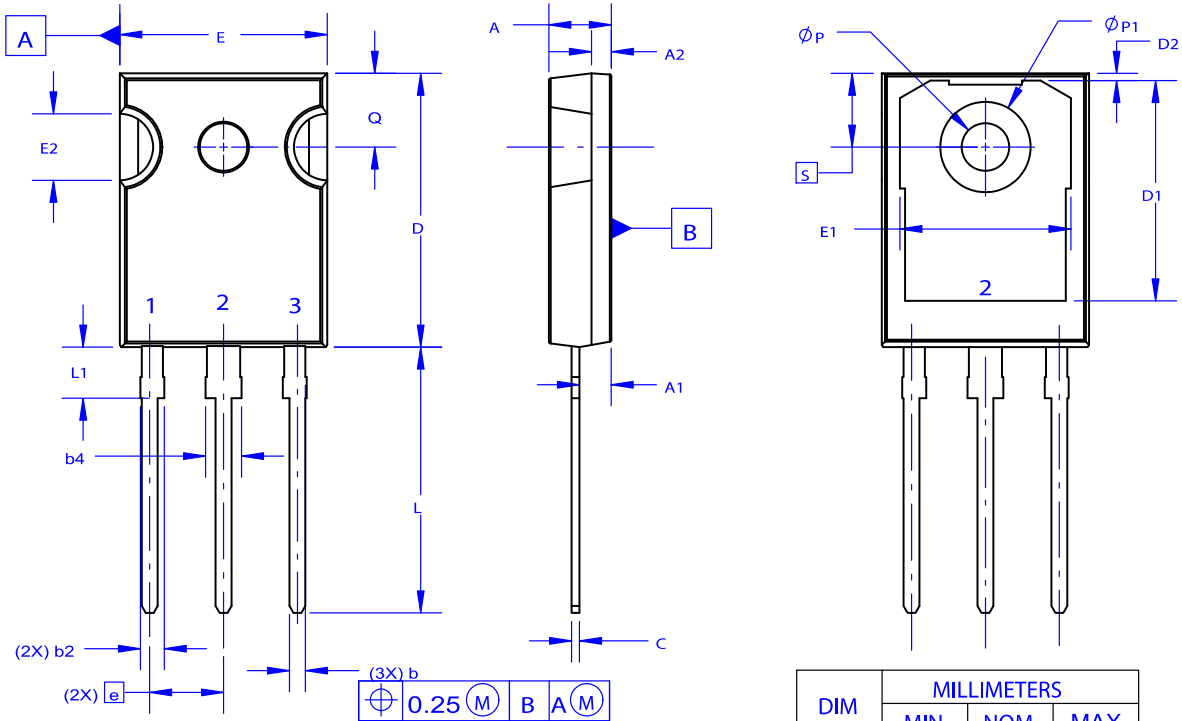
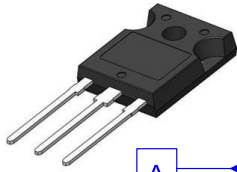
## PACKAGE DIMENSIONS

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.

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

### 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.

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