

# MOSFET – Power, N-Channel, SUPERFET III, Easy Drive

650 V, 19 A, 165 mΩ

**FCP165N65S3R0**

## Description

SUPERFET III MOSFET is onsemi'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 Easy drive series helps manage EMI issues and allows for easier design implementation.

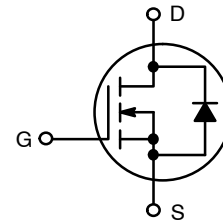
## Features

- 700 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 140\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 39\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 341\text{ pF}$ )
- 100% Avalanche Tested
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

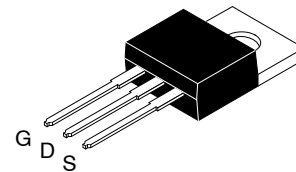
## Applications

- Computing / Display Power Supplies
- Telecom / Server Power Supplies
- Industrial Power Supplies
- Lighting / Charger / Adapter

$V_{DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
650 V	165 mΩ @ 10 V	19 A

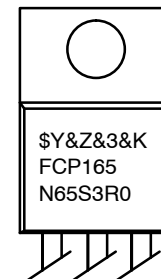


N-Channel MOSFET



TO-220-3LD  
CASE 340AT

## MARKING DIAGRAM



\$Y = onsemi Logo  
 &Z = Assembly Plant Code  
 &3 = Numeric Date Code  
 &K = Lot Code  
 FCP165N65S3R0 = Specific Device Code

## ORDERING INFORMATION

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

# FCP165N65S3R0

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

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)	19
		Continuous (T <sub>C</sub> = 100°C)	12.3
I <sub>DM</sub>	Drain Current	Pulsed (Note 1)	47.5
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)	87	mJ
I <sub>AS</sub>	Avalanche Current (Note 2)	2.7	A
E <sub>AR</sub>	Repetitive Avalanche Energy (Note 1)	1.54	mJ
dv/dt	MOSFET dv/dt	100	V/ns
	Peak Diode Recovery dv/dt (Note 3)	20	
P <sub>D</sub>	Power Dissipation	(T <sub>C</sub> = 25°C)	154
		Derate Above 25°C	1.23
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 s	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> = 2.7 A, R<sub>G</sub> = 25 Ω, starting T<sub>J</sub> = 25°C.
3. I<sub>SD</sub> ≤ 9.5 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.	0.81	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient, Max.	62.5	

## PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Top Marking	Package	Shipping
FCP165N65S3R0	FCP165N65S3R0	TO-220-3LD (Pb-Free / Halogen Free)	50 Units / Tube

# FCP165N65S3R0

## 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> = 1 mA, Referenced to 25°C		0.64		V/°C
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V			1	μA
		V <sub>DS</sub> = 520 V, T <sub>C</sub> = 125°C		0.85		
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> = 0.44 mA	2.5		4.5	V
R <sub>DS(on)</sub>	Static Drain to Source On Resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 9.5 A		140	165	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 9.5 A		12		S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 1 MHz		1500		pF
C <sub>oss</sub>	Output Capacitance			35		pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V		341		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		49		pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	V <sub>DS</sub> = 400 V, I <sub>D</sub> = 9.5 A, V <sub>GS</sub> = 10 V (Note 4)		39		nC
Q <sub>gs</sub>	Gate to Source Gate Charge			11		nC
Q <sub>gd</sub>	Gate to Drain "Miller" Charge			16		nC
ESR	Equivalent Series Resistance	f = 1 MHz		0.5		Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 400 V, I <sub>D</sub> = 9.5 A, V <sub>GS</sub> = 10 V, R <sub>g</sub> = 4.7 Ω (Note 4)		17		ns
t <sub>r</sub>	Turn-On Rise Time			15		ns
t <sub>d(off)</sub>	Turn-Off Delay Time			44		ns
t <sub>f</sub>	Turn-Off Fall Time			5		ns

### SOURCE-DRAIN DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Source to Drain Diode Forward Current			19		A
I <sub>SM</sub>	Maximum Pulsed Source to Drain Diode Forward Current			47.5		A
V <sub>SD</sub>	Source to Drain Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 9.5 A			1.2	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>DD</sub> = 400 V, I <sub>SD</sub> = 9.5 A, dI <sub>F</sub> /dt = 100 A/μs		339		ns
Q <sub>rr</sub>	Reverse Recovery Charge			5.8		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.

4. Essentially independent of operating temperature typical characteristics.

TYPICAL PERFORMANCE CHARACTERISTICS

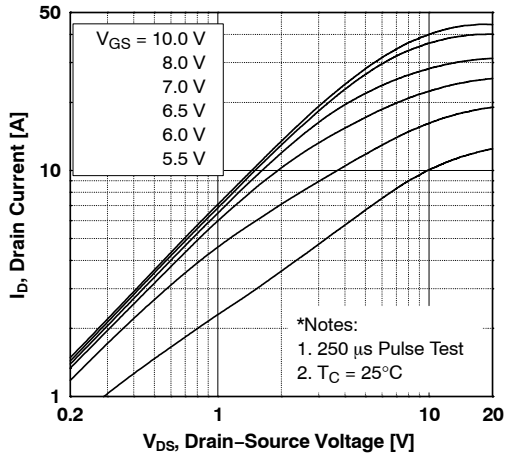


Figure 1. On-Region Characteristics

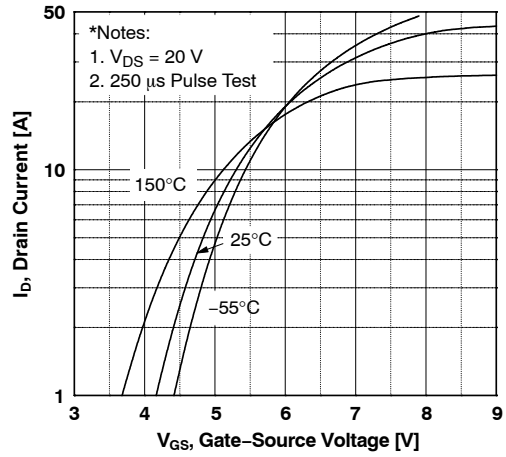


Figure 2. Transfer Characteristics

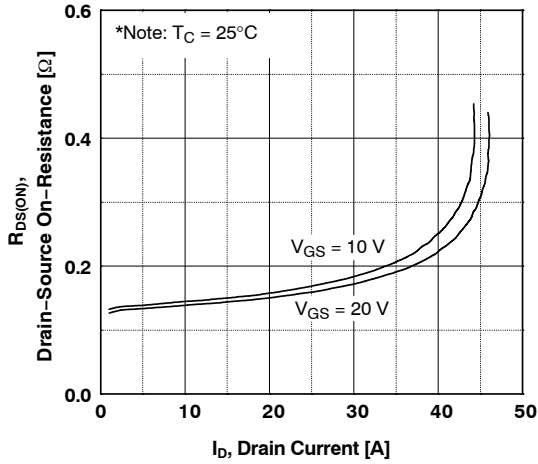


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

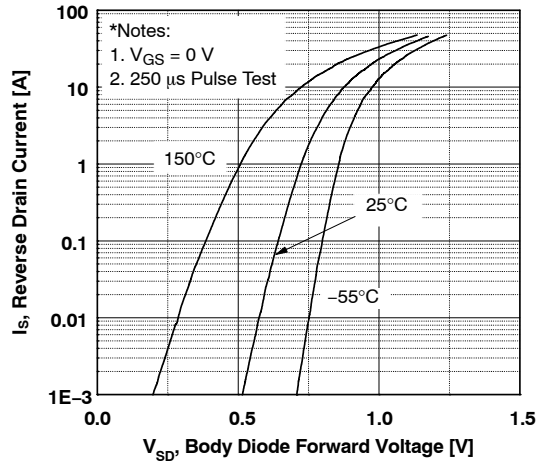


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

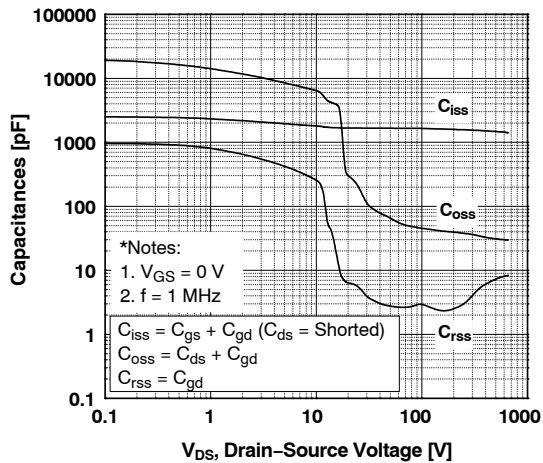


Figure 5. Capacitance Characteristics

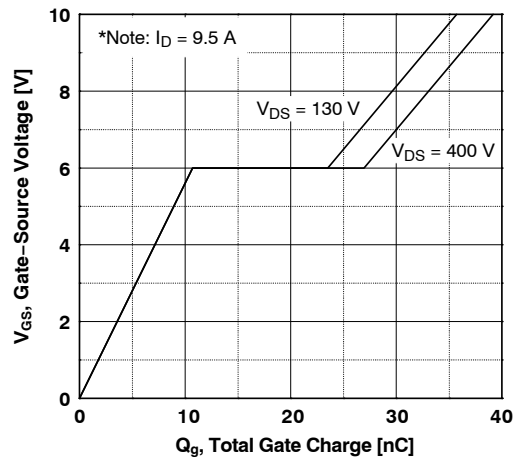


Figure 6. Gate Charge Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

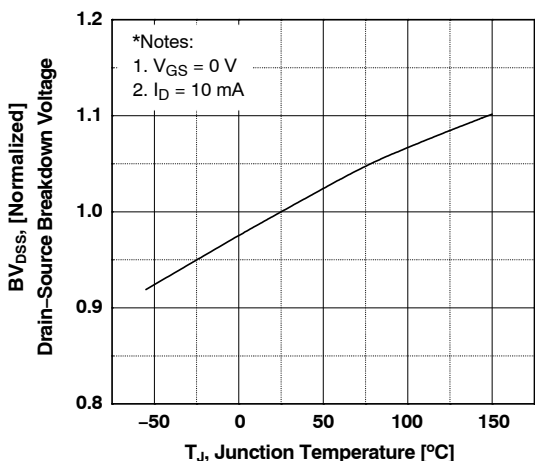


Figure 7. Breakdown Voltage Variation vs. Temperature

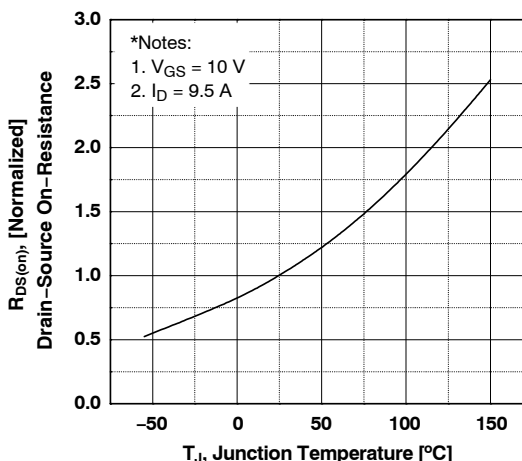


Figure 8. On-Resistance Variant vs. Temperature

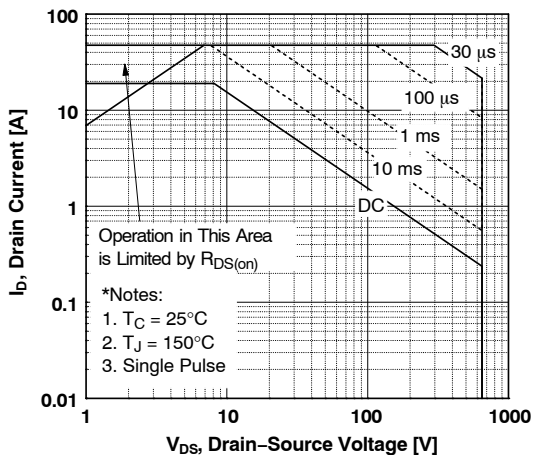


Figure 9. Maximum Safe Operation Area

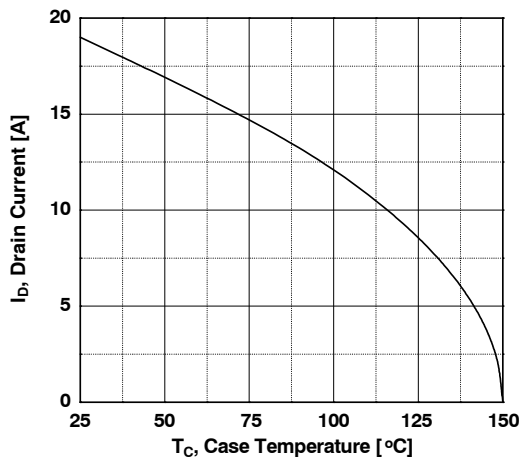


Figure 10. Maximum Drain Current vs. Case Temperature

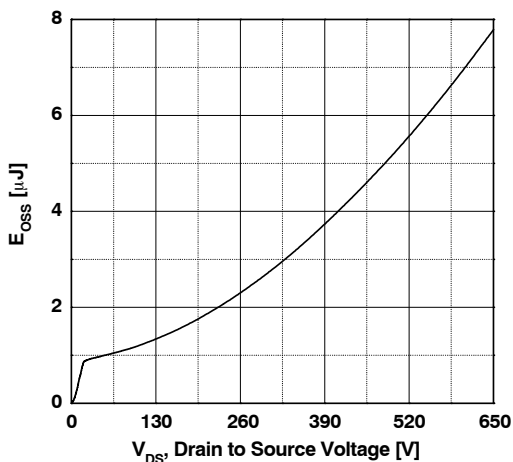


Figure 11. E<sub>OSS</sub> vs. Drain to Source Voltage

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## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

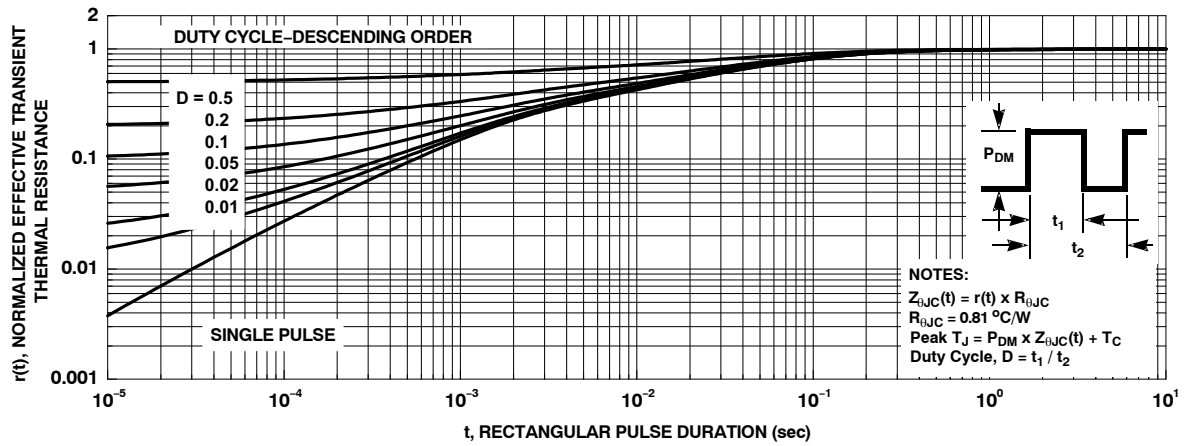


Figure 12. Transient Thermal Response Curve

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Figure 13. Gate Charge Test Circuit & Waveform

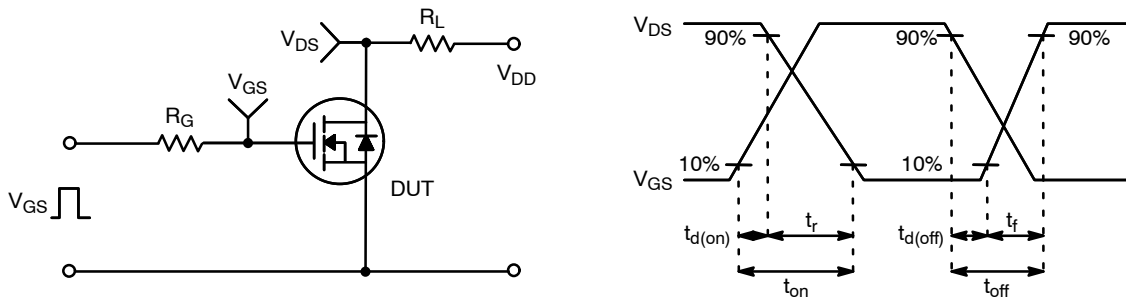


Figure 14. Resistive Switching Test Circuit & Waveforms

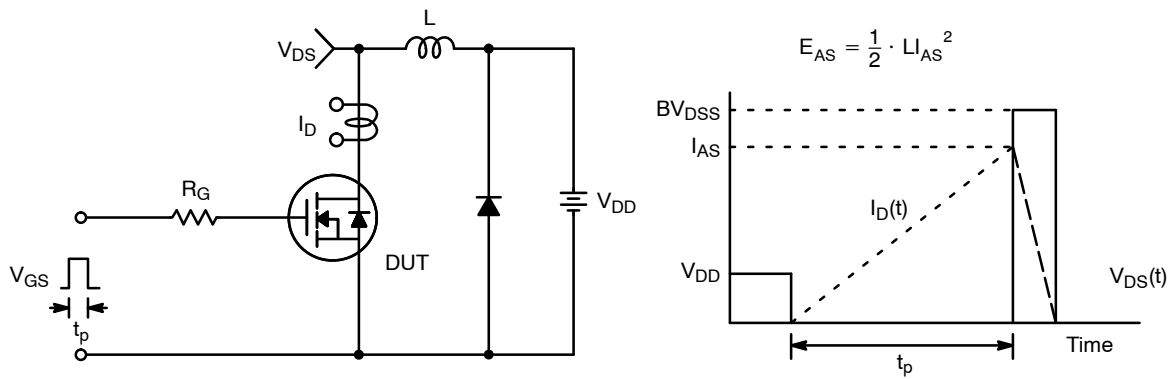
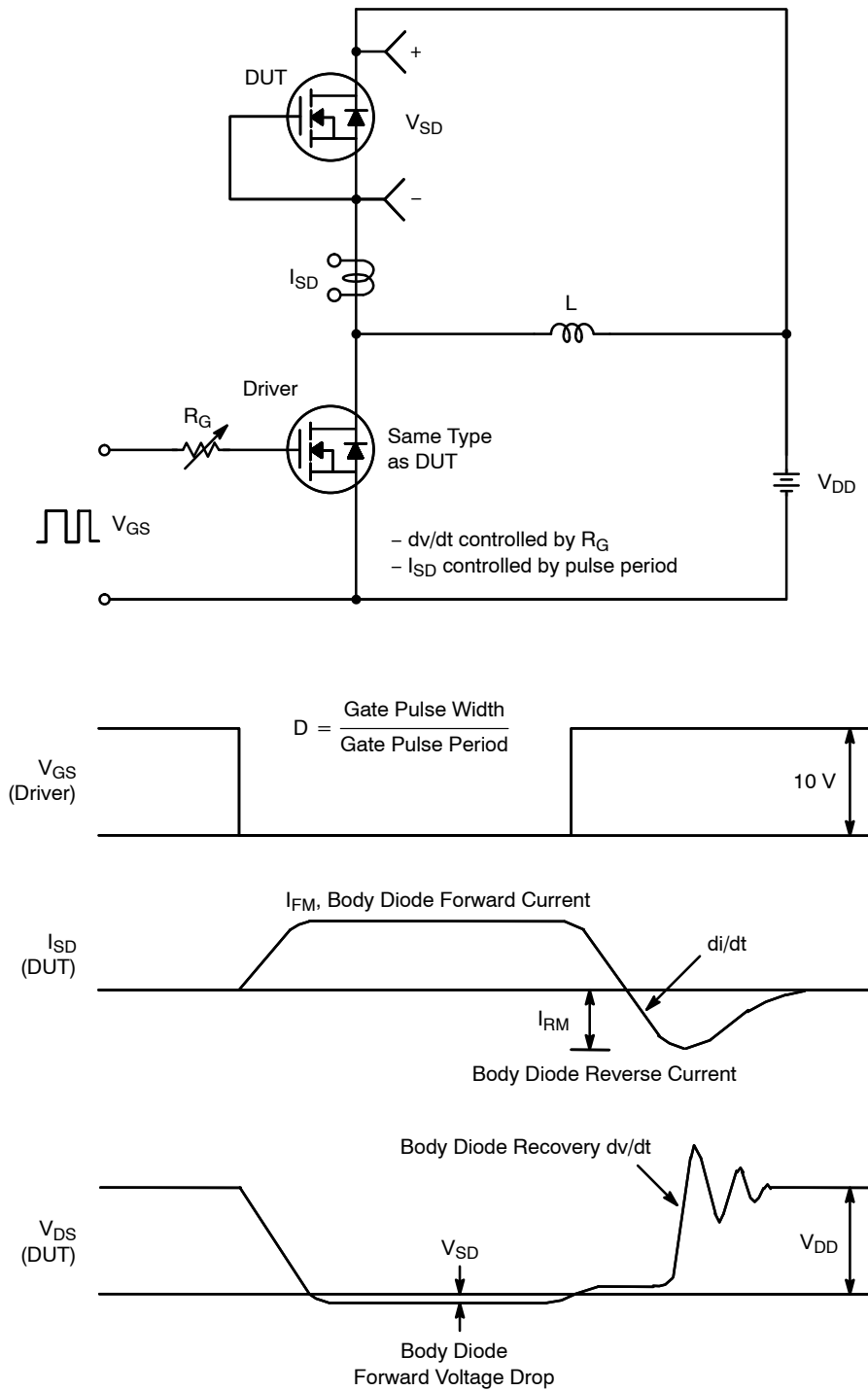


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

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



# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

ON Semiconductor®



Scale 1:1

### TO-220-3LD CASE 340AT ISSUE A

DATE 03 OCT 2017



- NOTES:
- A) REFERENCE JEDEC, TO-220, VARIATION AB
  - B) ALL DIMENSIONS ARE IN MILLIMETERS.
  - C) DIMENSIONS COMMON TO ALL PACKAGE SUPPLIERS EXCEPT WHERE NOTED [ ].
  - D) LOCATION OF MOLDED FEATURE MAY VARY (LOWER LEFT CORNER, LOWER CENTER AND CENTER OF THE PACKAGE)
  - E) DOES NOT COMPLY JEDEC STANDARD VALUE.
  - F) "A1" DIMENSIONS AS BELOW:  
 SINGLE GAUGE = 0.51 - 0.61  
 DUAL GAUGE = 1.10 - 1.45
  - G) PRESENCE IS SUPPLIER DEPENDENT
  - H) SUPPLIER DEPENDENT MOLD LOCKING HOLES IN HEATSINK.

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