

# MOSFET – N-Channel, SUPERFET<sup>®</sup> II, Easy-Drive

## 600 V, 23 A, 165 mΩ

### FCH165N60E

#### Description

SUPERFET II 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 technology is tailored to minimize conduction loss, provide superior switching performance, dv/dt rate and higher avalanche energy. Consequently, SUPERFET II MOSFET easy-drive series offers slightly slower rise and fall times compared to the SUPERFET II MOSFET series. Noted by the "E" part number suffix, this family helps manage EMI issues and allows for easier design implementation. For faster switching in applications where switching losses must be at an absolute minimum, please consider the SUPERFET II MOSFET series.

#### Features

- Typ.  $R_{DS(on)} = 132 \text{ m}\Omega$
- 650 V @  $T_J = 150^\circ\text{C}$
- Ultra Low Gate Charge (Typ.  $Q_g = 57 \text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 204 \text{ pF}$ )
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

#### Applications

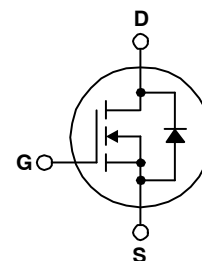
- Telecom / Server Power Supplies
- Industrial Power Supplies



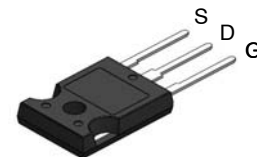
ON Semiconductor<sup>®</sup>

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$V_{DS}$	$R_{DS(on)} \text{ MAX}$	$I_D \text{ MAX}$
600 V	165 mΩ @ 10 V	23 A

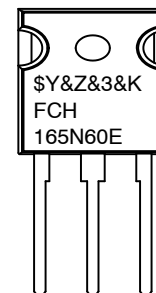


N-CHANNEL MOSFET



TO-247-3LD  
CASE 340CK

#### MARKING DIAGRAM



\$Y = ON Semiconductor Logo  
 &Z = Assembly Plant Code  
 &3 = Numeric Date Code  
 &K = Lot Code  
 FCH165N60E = Specific Device Code

#### ORDERING INFORMATION

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

# FCH165N60E

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

Symbol	Parameter	FCH165N60E	Unit
V <sub>DSS</sub>	Drain to Source Voltage	600	V
V <sub>GSS</sub>	Gate to Source Voltage	- DC	±20
		- AC (f > 1 Hz)	±30
I <sub>D</sub>	Drain Current:	- Continuous (T <sub>C</sub> = 25°C)	23
		- Continuous (T <sub>C</sub> = 100°C)	14
I <sub>DM</sub>	Drain Current:	- Pulsed (Note 1)	69
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)	525	mJ
I <sub>AR</sub>	Avalanche Current (Note 1)	5	A
E <sub>AR</sub>	Repetitive Avalanche Energy (Note 1)	2.27	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)	227
		- Derate Above 25°C	1.82
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	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> = 5.0 A, R<sub>G</sub> = 25 Ω, Starting T<sub>J</sub> = 25 °C.

3. I<sub>SD</sub> ≤ 11.5 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> ≤ 380 V, Starting T<sub>J</sub> = 25 °C.

## PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Top Marking	Package	Packing Method	Reel Size	Tape Width	Quantity
FCH165N60E	FCH165N60E	TO-247	Tube	N/A	N/A	30 Units

## THERMAL CHARACTERISTICS

Symbol	Parameter	FCH165N60E	Unit
R <sub>θJC</sub>	Thermal Resistance, Junction to Case, Max.	0.55	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient, Max.	40	

# FCH165N60E

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
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### OFF CHARACTERISTICS

BV <sub>DSS</sub>	Drain to Source Breakdown Voltage	I <sub>D</sub> = 10 mA, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 25°C	600	–	–	V
		I <sub>D</sub> = 10 mA, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 150°C	650	–	–	
ΔBV <sub>DSS</sub> / ΔT <sub>J</sub>	Breakdown Voltage Temperature Coefficient	I <sub>D</sub> = 10 mA, Referenced to 25°C	–	0.7	–	V/°C
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V	–	–	1	μA
		V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V, T <sub>C</sub> = 125 °C	–	1.46	–	
I <sub>GSS</sub>	Gate to Body Leakage Current	V <sub>GS</sub> = ±20 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> = 250 μA	2.5	–	3.5	V
R <sub>DS(on)</sub>	Static Drain to Source On Resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 11.5 A	–	132	165	mΩ
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 11.5 A	–	20	–	S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 380 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	1830	2434	pF
C <sub>oss</sub>	Output Capacitance		–	50	67	pF
C <sub>rss</sub>	Reverse Transfer Capacitance		–	8.6	–	pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 480 V, V <sub>GS</sub> = 0 V	–	204	–	pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	V <sub>DS</sub> = 380 V, I <sub>D</sub> = 11.5 A, V <sub>GS</sub> = 10 V (Note 4)	–	57	75	nC
Q <sub>gs</sub>	Gate to Source Gate Charge		–	8.3	–	nC
Q <sub>gd</sub>	Gate to Drain “Miller” Charge		–	24	–	nC
ESR	Equivalent Series Resistance	f = 1 MHz	–	6	–	Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 380 V, I <sub>D</sub> = 11.5 A, V <sub>GS</sub> = 10 V, R <sub>g</sub> = 4.7 Ω (Note 4)	–	22	55	ns
t <sub>r</sub>	Turn-On Rise Time		–	18	46	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		–	100	210	ns
t <sub>f</sub>	Turn-Off Fall Time		–	18	47	ns

### DRAIN-SOURCE DIODE CHARACTERISTICS

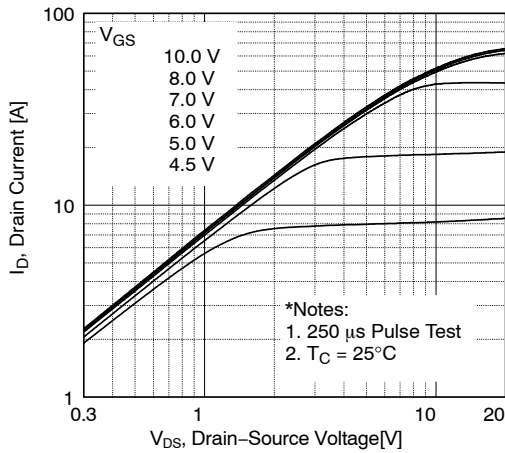
I <sub>S</sub>	Maximum Continuous Source to Drain Diode Forward Current	–	–	23	A	
I <sub>SM</sub>	Maximum Pulsed Drain to Source Diode Forward Current	–	–	69	A	
V <sub>SD</sub>	Drain to Source Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 11.5 A	–	–	1.2	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 11.5 A, di <sub>F</sub> /dt = 100 A/μs	–	326	–	ns
Q <sub>rr</sub>	Reverse Recovery Charge		–	5.3	–	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.

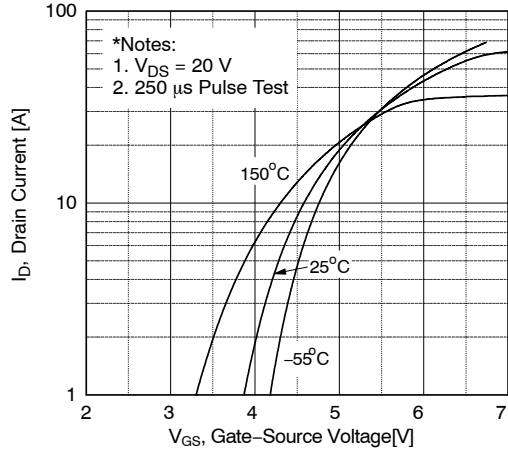
4. Essentially independent of operating temperature.

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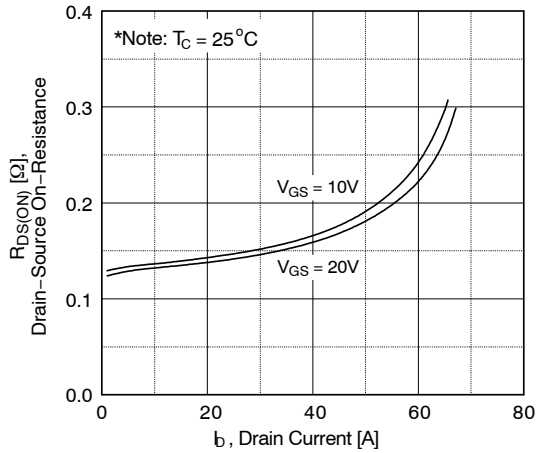
## TYPICAL CHARACTERISTICS



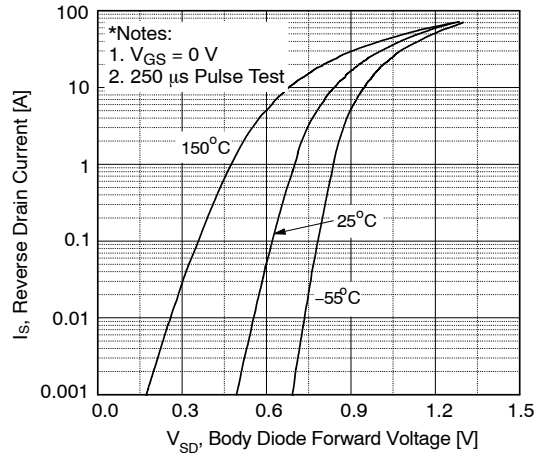
**Figure 1. On-Region Characteristics**



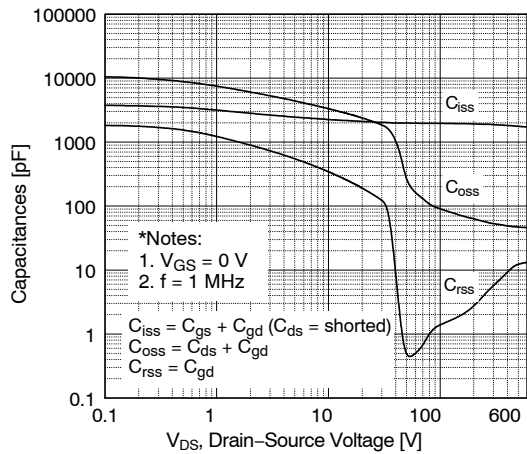
**Figure 2. Transfer Characteristics**



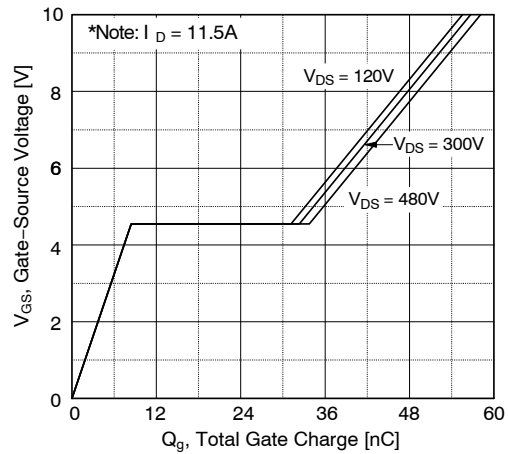
**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**



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



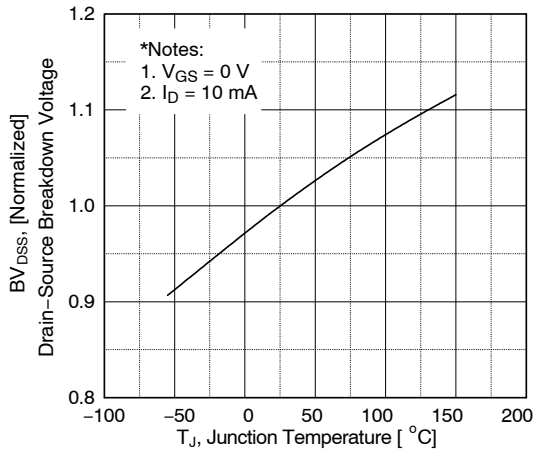
**Figure 5. Capacitance Characteristics**



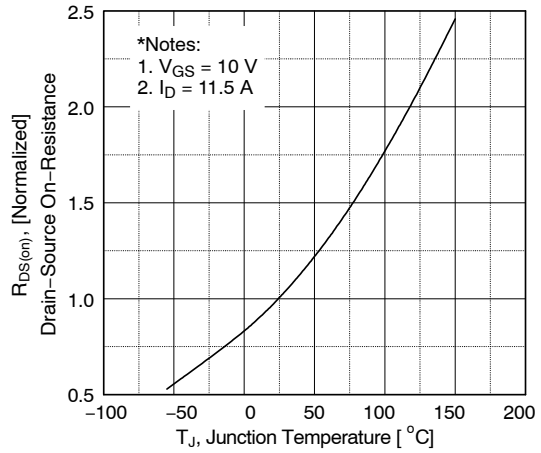
**Figure 6. Gate Charge Characteristics**

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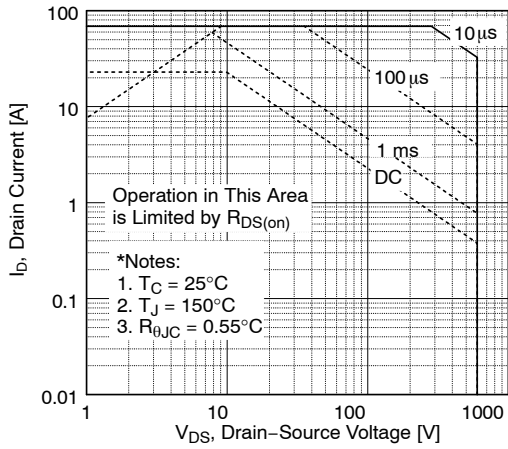
## TYPICAL CHARACTERISTICS



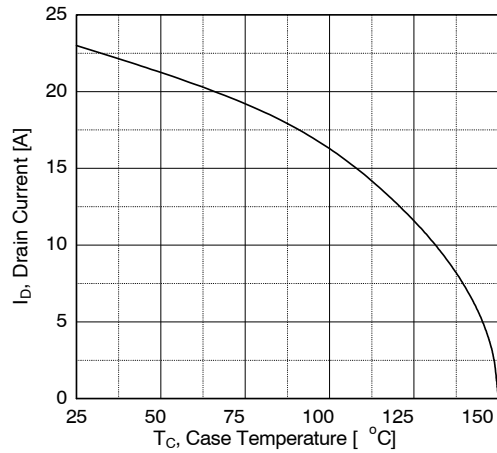
**Figure 7. Breakdown Voltage Variation vs. Temperature**



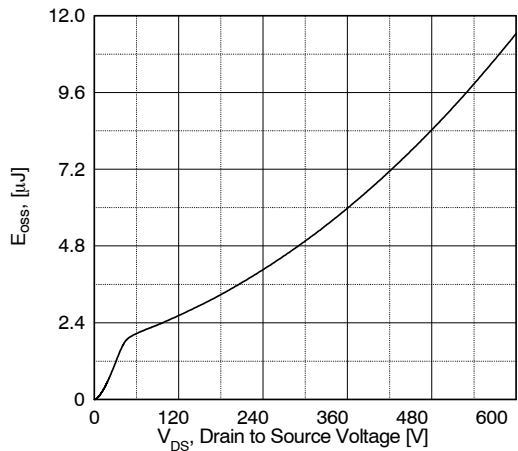
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**



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



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

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## TYPICAL CHARACTERISTICS

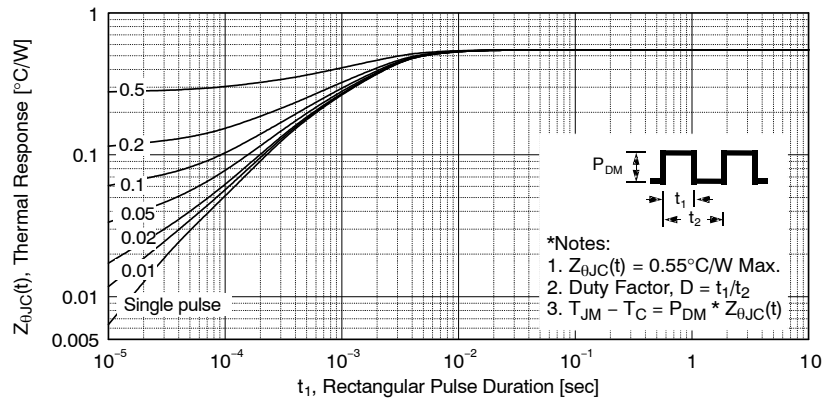


Figure 12. Transient Thermal Response Curve

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Figure 13. Gate Charge Test Circuit & Waveform

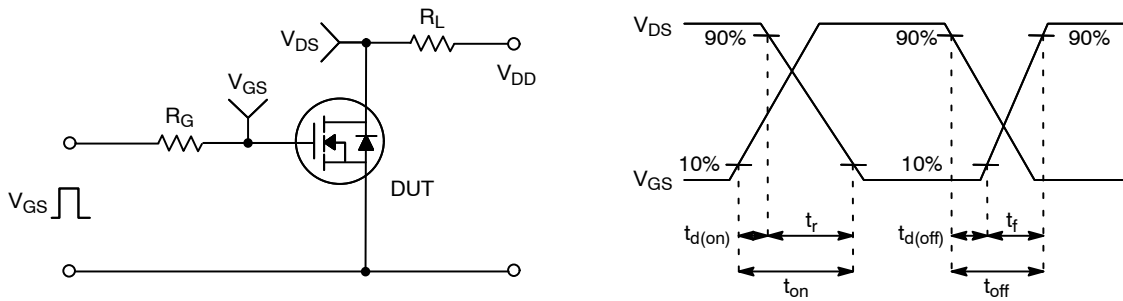
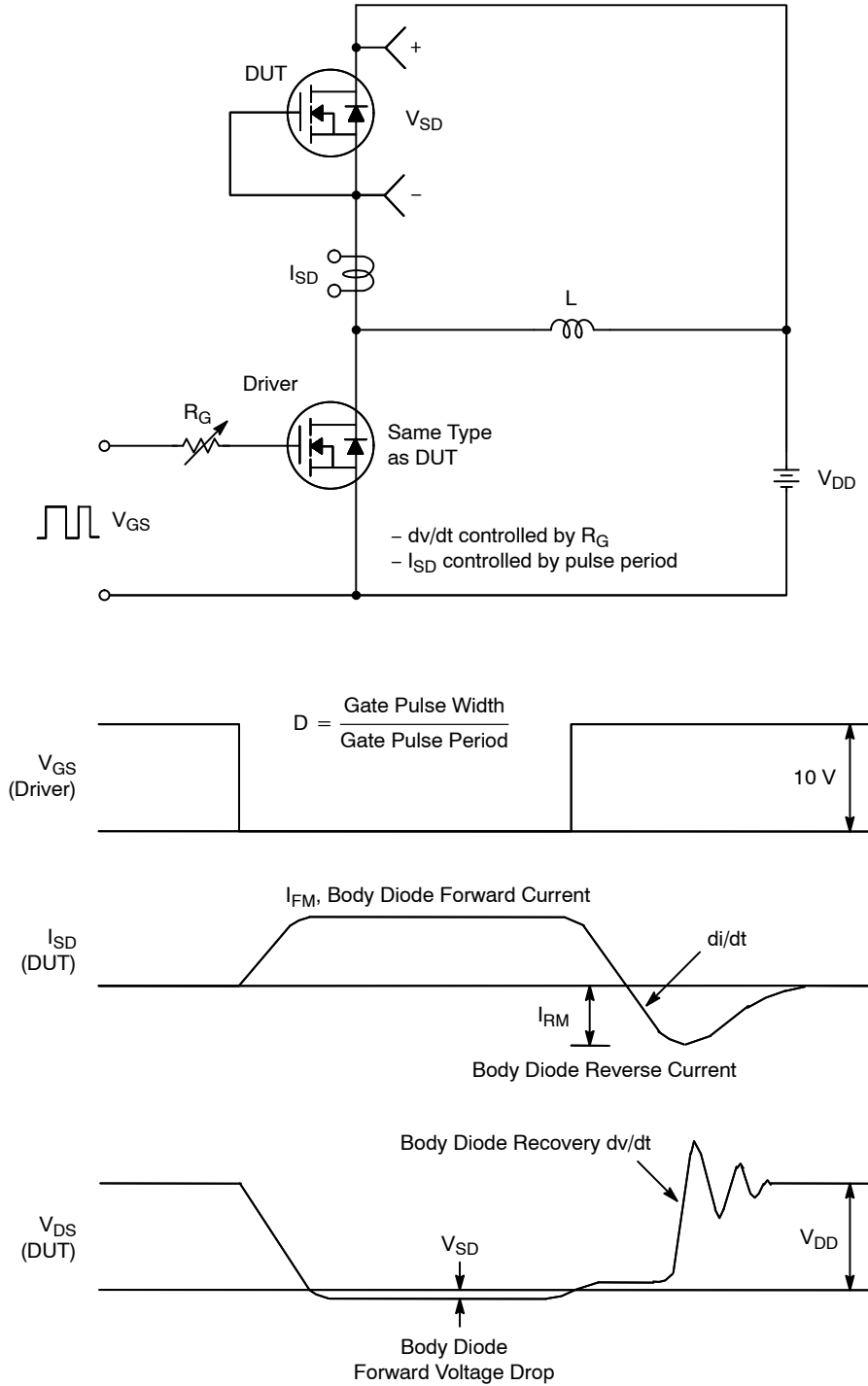


Figure 14. Resistive Switching Test Circuit & Waveforms



Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

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

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**TO-247-3LD SHORT LEAD**  
**CASE 340CK**  
**ISSUE A**

DATE 31 JAN 2019



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\***



- XXXX = Specific Device Code
- A = Assembly Location
- Y = Year
- WW = Work Week
- ZZ = Assembly Lot Code

\*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
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
D	20.32	20.57	20.82
D1	13.08	~	~
D2	0.51	0.93	1.35
E	15.37	15.62	15.87
E1	12.81	~	~
E2	4.96	5.08	5.20
e	~	5.56	~
L	15.75	16.00	16.25
L1	3.69	3.81	3.93
ØP	3.51	3.58	3.65
ØP1	6.60	6.80	7.00
Q	5.34	5.46	5.58
S	5.34	5.46	5.58

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