

# MOSFET – N-Channel, SUPERFET® II

**800 V, 14 A, 400 mΩ**

## FCPF400N80Z

### Description

SUPERFET II 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 technology is tailored to minimize conduction loss, provide superior switching performance, dv/dt rate and higher avalanche energy. In addition, internal gate–source ESD diode allows to withstand over 2 kV HBM surge stress. Consequently, SUPERFET II MOSFET is very suitable for the switching power applications such as Audio, Laptop adapter, Lighting, ATX power and industrial power applications.

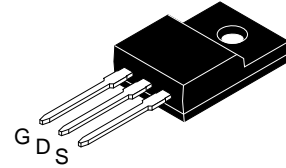
### Features

- Typ.  $R_{DS(on)} = 340\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 43\text{ nC}$ )
- Low  $E_{oss}$  (Typ.  $4.1\text{ }\mu\text{J @ }400\text{ V}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 138\text{ pF}$ )
- 100% Avalanche Tested
- ESD Improved Capability
- RoHS Compliant

### Applications

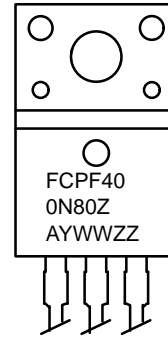
- AC–DC Power Supply
- LED Lighting

$V_{DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
800 V	400 mΩ @ 10 V	14 A



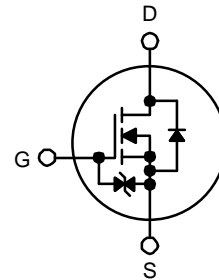
TO–220 Fullpack, 3–Lead / TO–220F–3SG  
 CASE 221AT

### MARKING DIAGRAM



FCPF400N80Z = Specific Device Code  
 A = Assembly Location  
 YWW = Date Code (Year & Week)  
 ZZ = Assembly Lot

### N-CHANNEL MOSFET



### ORDERING INFORMATION

Part Number	Package	Shipping
FCPF400N80Z	TO–220F	1000 Units / Tube

# FCPF400N80Z

## ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ , unless otherwise noted)

Symbol	Parameter		FCPF400N80Z	Unit
$V_{DSS}$	Drain to Source Voltage		800	V
$V_{GSS}$	Gate to Source Voltage	- DC	$\pm 20$	V
		- AC ( $f > 1$ Hz)	$\pm 30$	
$I_D$	Drain Current	- Continuous ( $T_C = 25^\circ\text{C}$ )	14*	A
		- Continuous ( $T_C = 100^\circ\text{C}$ )	8.9*	
$I_{DM}$	Drain Current	- Pulsed (Note 1)	33*	A
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)		339	mJ
$I_{AR}$	Avalanche Current (Note 1)		2.2	A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)		0.36	mJ
dv/dt	MOSFET dv/dt		100	V/ns
	Peak Diode Recovery dv/dt (Note 3)		20	
$P_D$	Power Dissipation	( $T_C = 25^\circ\text{C}$ )	35.7	W
		- Derate Above $25^\circ\text{C}$	0.29	
$T_J, T_{STG}$	Operating and Storage Temperature Range		-55 to +150	$^\circ\text{C}$
$T_L$	Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds		300	$^\circ\text{C}$

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, with heatsink.

1. Repetitive rating: pulse-width limited by maximum junction temperature.

2.  $I_{AS} = 2.2$  A,  $V_{DD} = 50$  V,  $R_G = 25$   $\Omega$ , starting  $T_J = 25^\circ\text{C}$ .

3.  $I_{SD} \leq 14$  A,  $di/dt \leq 200$  A/ $\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .

## THERMAL CHARACTERISTICS

Symbol	Parameter	FCPF400N80Z	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	3.5	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	62.5	

# FCPF400N80Z

## 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	800	–	–	V
ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	Breakdown Voltage Temperature Coefficient	I <sub>D</sub> = 1 mA, Referenced to 25°C	–	0.8	–	V/°C
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> = 800 V, V <sub>GS</sub> = 0 V	–	–	25	μA
		V <sub>DS</sub> = 640 V, T <sub>C</sub> = 125°C	–	–	250	
I <sub>GSS</sub>	Gate to Body Leakage Current	V <sub>GS</sub> = ±20 V, V <sub>DS</sub> = 0 V	–	–	±10	μA

### ON CHARACTERISTICS

V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.1 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> = 5.5 A	–	0.34	0.4	Ω
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 5.5 A	–	12	–	S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 100 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	1770	2350	pF
C <sub>oss</sub>	Output Capacitance		–	51	70	pF
C <sub>rss</sub>	Reverse Transfer Capacitance		–	0.5	–	pF
C <sub>oss</sub>	Output Capacitance	V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	28	–	pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 480 V, V <sub>GS</sub> = 0 V	–	138	–	pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	V <sub>DS</sub> = 640 V, I <sub>D</sub> = 11 A, V <sub>GS</sub> = 10 V (Note 4)	–	43	56	nC
Q <sub>gs</sub>	Gate to Source Gate Charge		–	8.6	–	nC
Q <sub>gd</sub>	Gate to Drain “Miller” Charge		–	17	–	nC
ESR	Equivalent Series Resistance	f = 1 MHz	–	2.3	–	Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 400 V, I <sub>D</sub> = 11 A, V <sub>GS</sub> = 10 V, R <sub>g</sub> = 4.7 Ω (Note 4)	–	20	50	ns
t <sub>r</sub>	Turn-On Rise Time		–	12	34	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		–	51	112	ns
t <sub>f</sub>	Turn-Off Fall Time		–	2.6	15	ns

### DRAIN-SOURCE DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Drain to Source Diode Forward Current	–	–	14	A	
I <sub>SM</sub>	Maximum Pulsed Drain to Source Diode Forward Current	–	–	33	A	
V <sub>SD</sub>	Drain to Source Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 11 A	–	–	1.2	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 11 A, dI <sub>F</sub> /dt = 100 A/μs	–	395	–	ns
Q <sub>rr</sub>	Reverse Recovery Charge		–	7.4	–	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

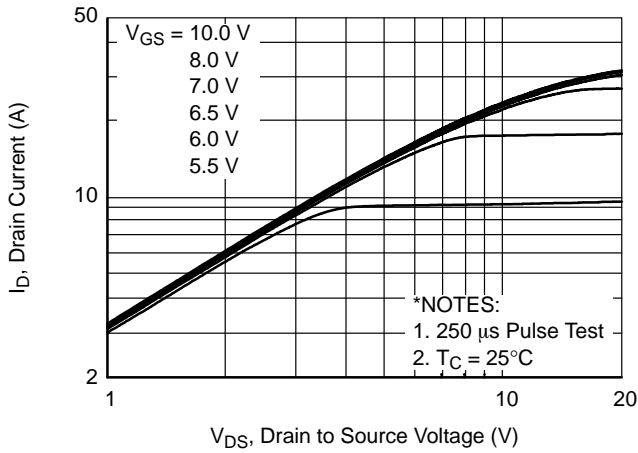


Figure 1. On-Region Characteristics

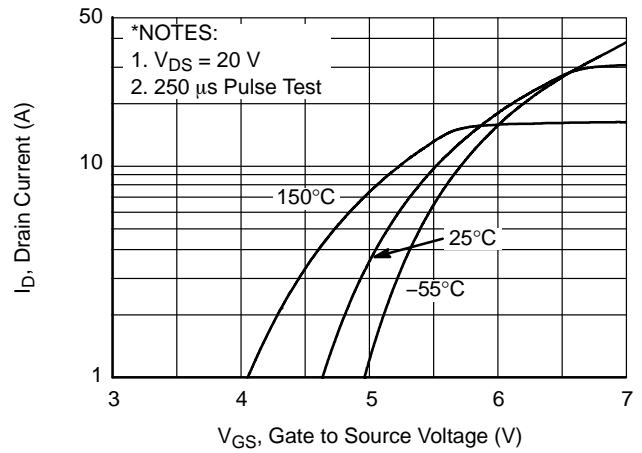


Figure 2. Transfer Characteristics

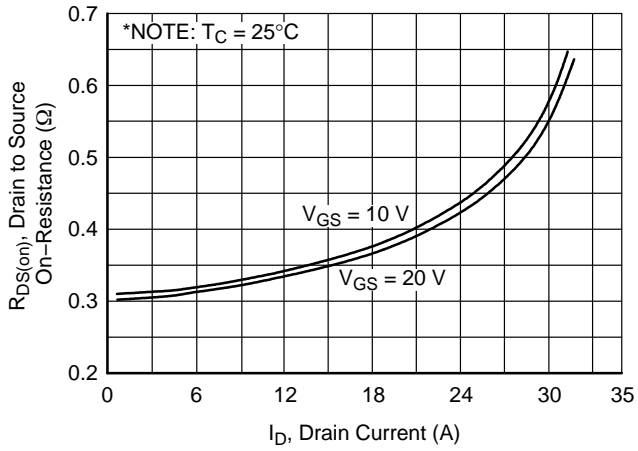


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

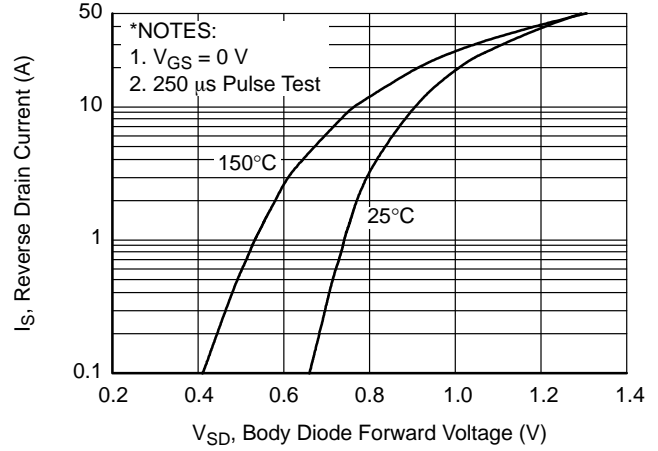


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

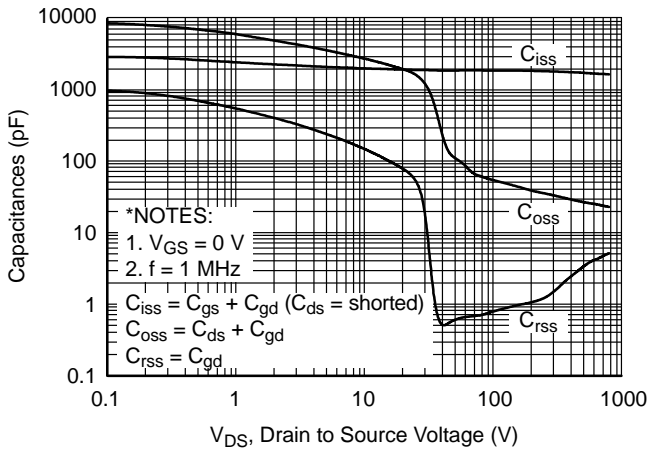


Figure 5. Capacitance Characteristics

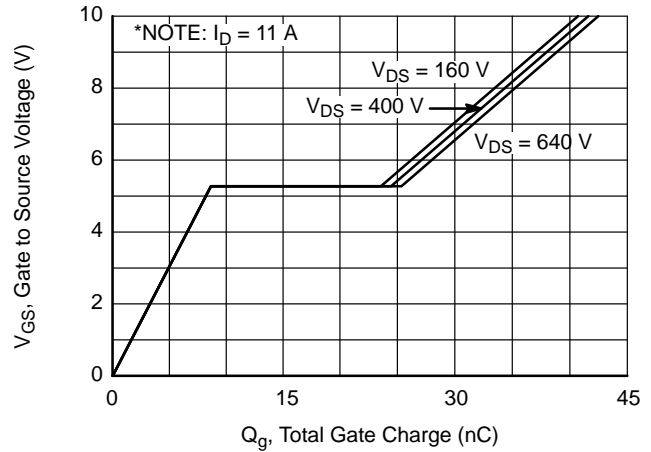
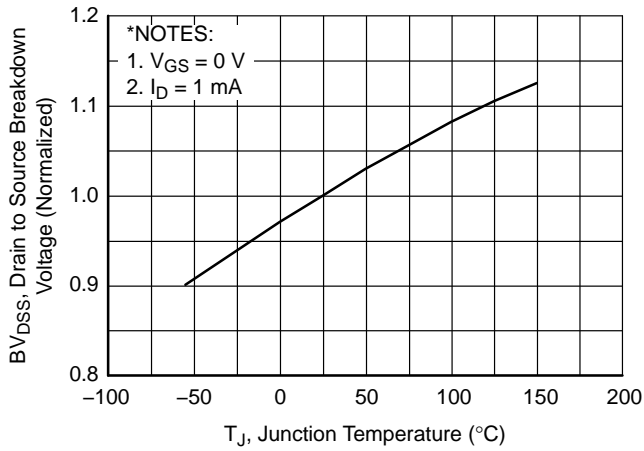


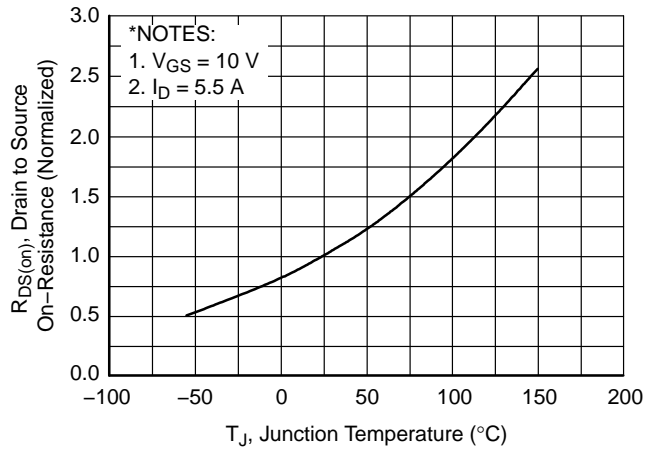
Figure 6. Gate Charge Characteristics

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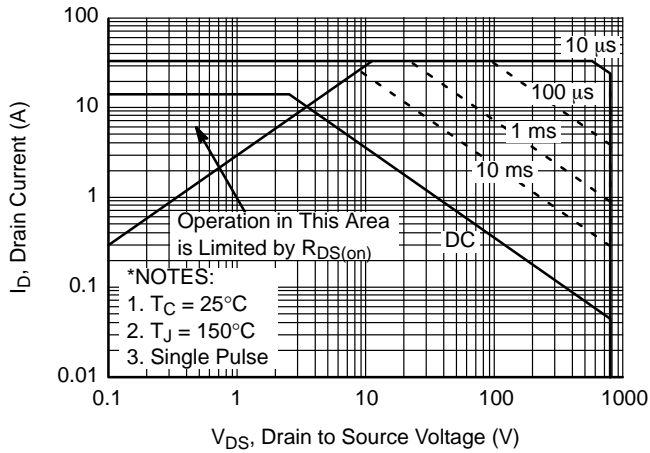
## TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)



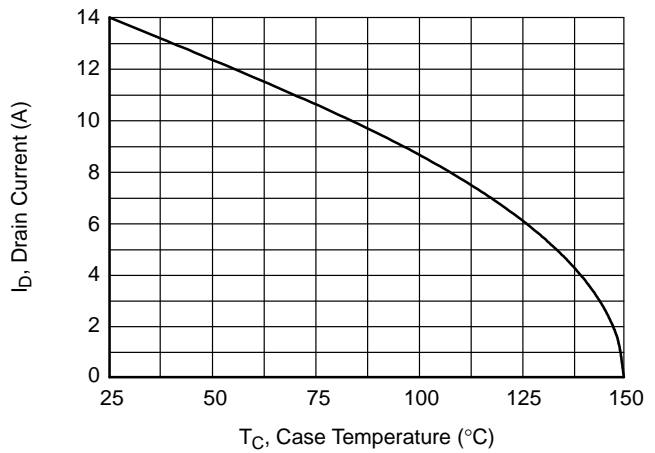
**Figure 7. Breakdown Voltage Variation vs. Temperature**



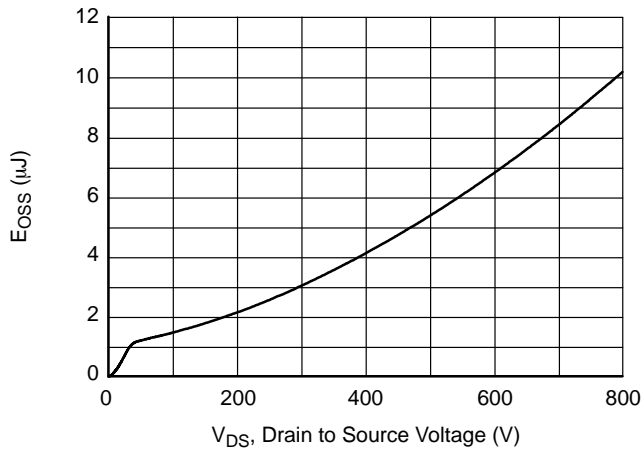
**Figure 8. On-Resistance Variation vs. Temperature**



**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 PERFORMANCE CHARACTERISTICS (CONTINUED)

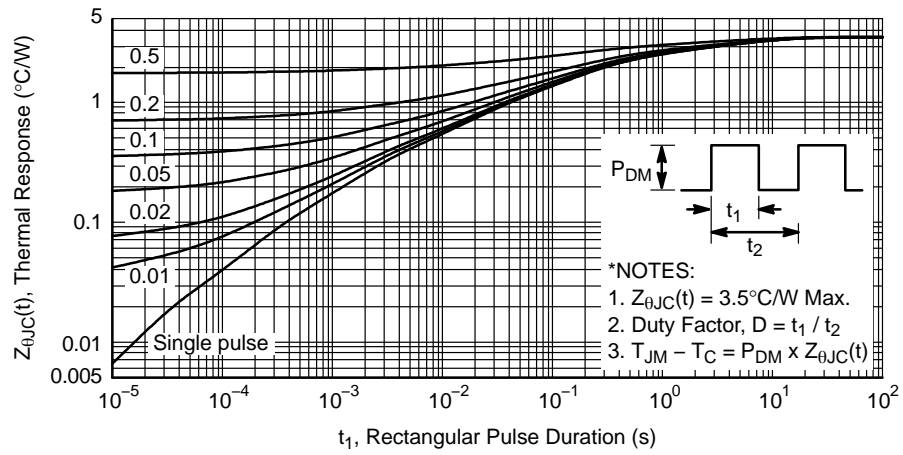


Figure 12. Transient Thermal Response Curve

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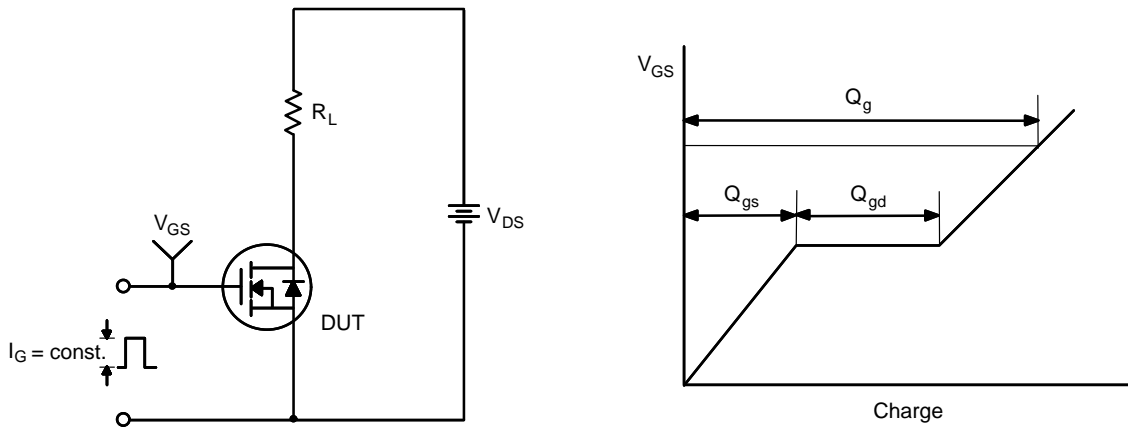


Figure 13. Gate Charge Test Circuit & Waveform

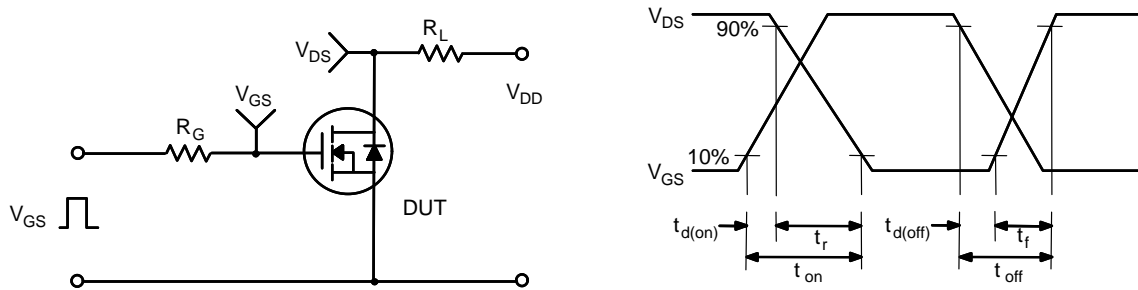


Figure 14. Resistive Switching Test Circuit & Waveforms

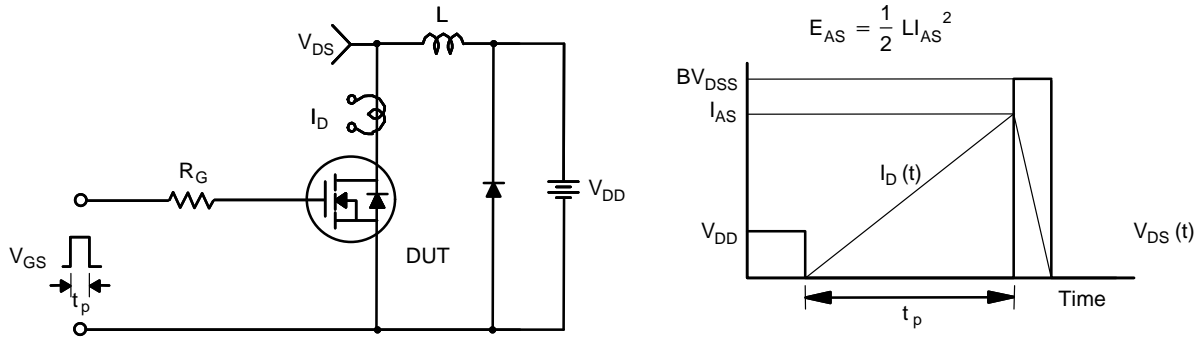
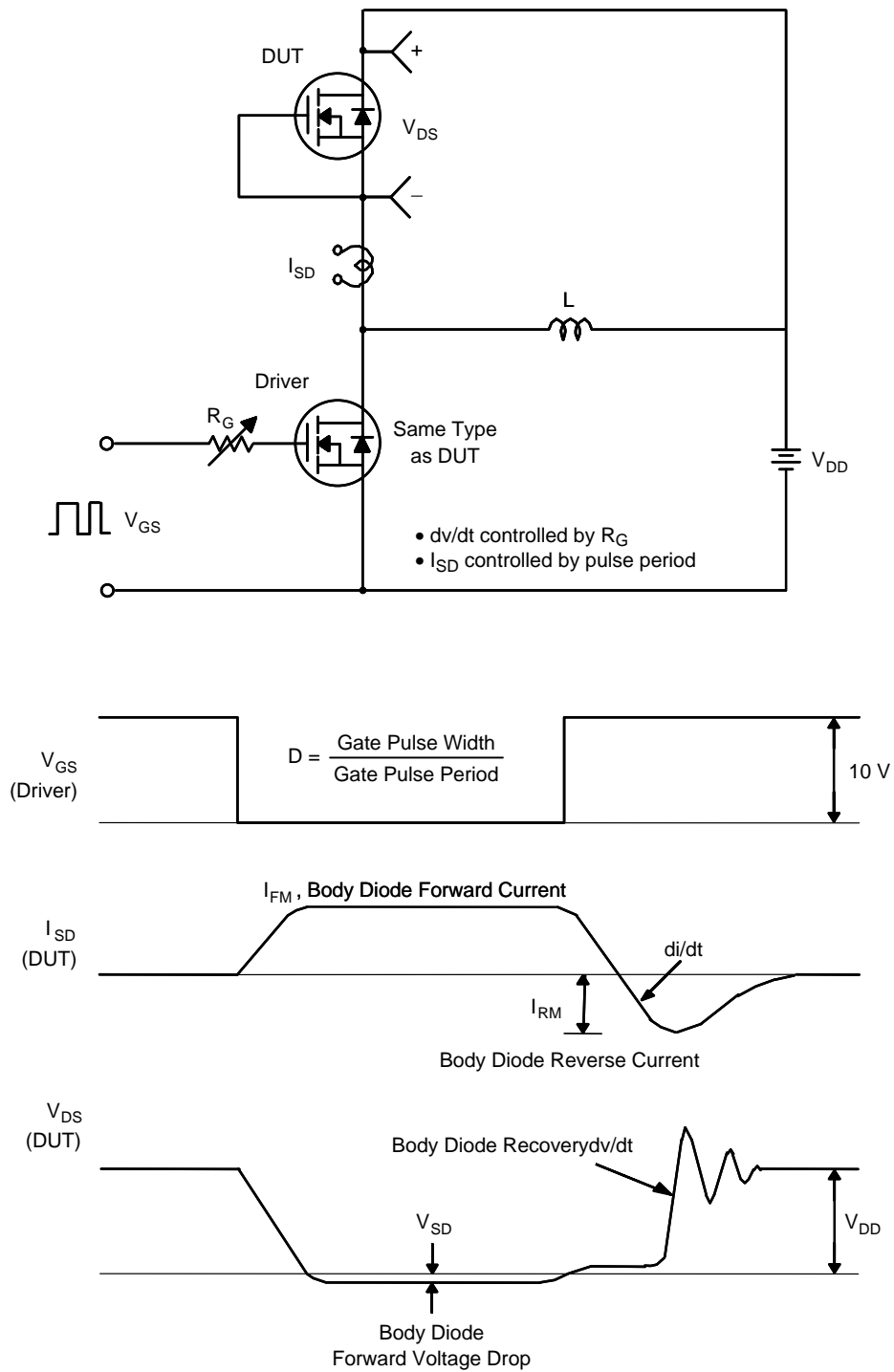


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

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



# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

ON Semiconductor®

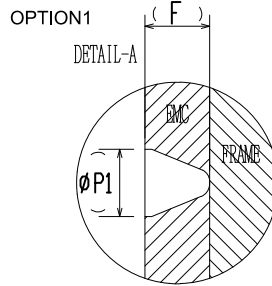
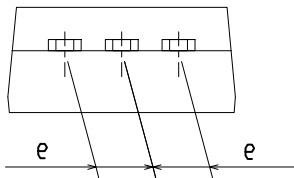


### TO-220 Fullpack, 3-Lead / TO-220F-3SG CASE 221AT ISSUE B

DATE 19 JAN 2021



Scale 1:1



DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.50	4.70	4.90
A1	2.56	2.76	2.96
A2	2.34	2.54	2.74
b	0.70	0.80	0.90
b2	~	~	1.47
c	0.45	0.50	0.60
D	15.67	15.87	16.07
D1	15.60	15.80	16.00
E	9.96	10.16	10.36
e	2.34	2.54	2.74
F	~	0.84	~
H1	6.48	6.68	6.88
L	12.78	12.98	13.18
L1	3.03	3.23	3.43
$\phi P$	2.98	3.18	3.38
$\phi P1$	~	1.00	~
Q	3.20	3.30	3.40

**NOTES:**

- A. DIMENSION AND TOLERANCE AS ASME Y14.5-2009
- B. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUCTIONS.
- C. OPTION 1 - WITH SUPPORT PIN HOLE  
OPTION 2 - NO SUPPORT PIN HOLE

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