

# MOSFET – N-Channel, SUPERFET® II

600 V, 7.4 A, 600 mΩ

## FCP600N60Z, FCPF600N60Z

### 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. Consequently, SUPERFET II MOSFET is very suitable for the switching power applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications.

### Features

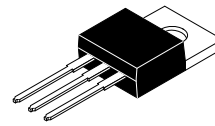
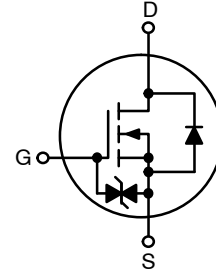
- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 510\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 20\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 74\text{ pF}$ )
- 100% Avalanche Tested
- ESD Improved Capacity
- RoHS Compliant

### Applications

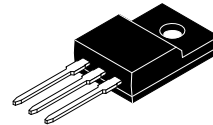
- LCD/LED/PDP TV and Monitor Lighting
- Solar Inverter
- AC-DC Power Supply

$V_{DSS}$	$R_{DS(ON)}\text{ MAX}$	$I_D\text{ MAX}$
600 V	0.6 $\Omega$ @ 10 V	7.4 A*

\*Drain current limited by maximum junction temperature.

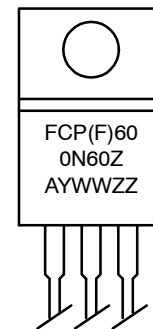


TO-220-3LD  
 CASE 340AT



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

### MARKING DIAGRAM



FCP(F)600N60Z = Device Code  
 A = Assembly Location  
 YWW = Date Code (Year & Week)  
 ZZ = Assembly Lot

### ORDERING INFORMATION

Device	Package	Shipping
FCP600N60Z	TO-220-3LD	800 Units / Tube
FCPF600N60Z	TO-220 Fullpack	1000 Units / Tube

## FCP600N60Z, FCPF600N60Z

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

Symbol	Parameter	FCP600N60Z	FCPF600N60Z	Unit	
$V_{DSS}$	Drain to Source Voltage	600		V	
$V_{GSS}$	Gate to Source Voltage	-DC	$\pm 20$	V	
		-AC ( $f > 1$ Hz)	$\pm 30$		
$I_D$	Drain Current	- Continuous ( $T_C = 25^\circ\text{C}$ )	7.4	7.4*	A
		- Continuous ( $T_C = 100^\circ\text{C}$ )	4.7	4.7*	
$I_{DM}$	Drain Current	- Pulsed (Note 1)	22.2	22.2*	A
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)	135		mJ	
$I_{AR}$	Avalanche Current (Note 1)	1.5		A	
$E_{AR}$	Repetitive Avalanche Energy (Note 1)	0.89		mJ	
dv/dt	MOSFET dv/dt	100		V/ns	
	Peak Diode Recovery dv/dt (Note 3)	20			
$P_D$	Power Dissipation	( $T_C = 25^\circ\text{C}$ )	89	28	W
		-Derate above $25^\circ\text{C}$	0.71	0.22	
$T_J, T_{STG}$	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.

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2.  $I_{AS} = 1.5$  A,  $V_{DD} = 50$  V,  $R_G = 25$   $\Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 3.7$  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	FCP600N60Z	FCPF600N60Z	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	1.4	4.5	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	62.5	62.5	

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## 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> = 10 mA, T <sub>J</sub> = 25°C	600	–	–	V
		V <sub>GS</sub> = 0 V, I <sub>D</sub> = 10 mA, T <sub>J</sub> = 150°C	650	–	–	
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	I <sub>D</sub> = 10 mA, referenced to 25°C	–	0.67	–	V/°C
BV <sub>DS</sub>	Drain to Source Avalanche Breakdown Voltage	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 7.4 A	–	700	–	V
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, T <sub>C</sub> = 125°C	–	1.32	–	
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> = 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> = 3.7 A	–	0.51	0.6	Ω
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 3.7 A	–	6.7	–	S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	840	1120	pF
C <sub>oss</sub>	Output Capacitance		–	630	840	
C <sub>rss</sub>	Reverse Transfer Capacitance		–	30	45	
C <sub>oss</sub>	Output Capacitance	V <sub>DS</sub> = 380 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	16.5	–	pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 480 V, V <sub>GS</sub> = 0 V	–	74	–	pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	V <sub>DS</sub> = 380 V, I <sub>D</sub> = 3.7 A, V <sub>GS</sub> = 10 V (Note 4)	–	20	26	nC
Q <sub>gs</sub>	Gate to Source Gate Charge		–	3.4	–	
Q <sub>gd</sub>	Gate to Drain “Miller” Charge		–	7.5	–	
ESR	Equivalent Series Resistance	f = 1 MHz	–	2.89	–	Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 380 V, I <sub>D</sub> = 3.7 A, V <sub>GS</sub> = 10 V, R <sub>G</sub> = 4.7 Ω (Note 4)	–	13	36	ns
t <sub>r</sub>	Turn-On Rise Time		–	7	24	
t <sub>d(off)</sub>	Turn-Off Delay Time		–	39	88	
t <sub>f</sub>	Turn-Off Fall Time		–	9	28	

### DRAIN-SOURCE DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Drain to Source Diode Forward Current	–	–	7.4	A	
I <sub>SM</sub>	Maximum Pulsed Drain to Source Diode Forward Current	–	–	22.2	A	
V <sub>SD</sub>	Drain to Source Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 3.7 A	–	–	1.2	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 3.7 A, dI <sub>F</sub> /dt = 100 A/μs	–	200	–	ns
Q <sub>rr</sub>	Reverse Recovery Charge		–	2.3	–	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 typical characteristics.

TYPICAL PERFORMANCE CHARACTERISTICS

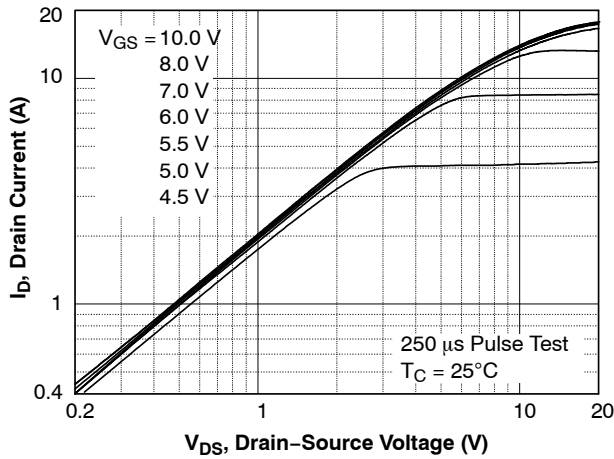


Figure 1. On-Region Characteristics

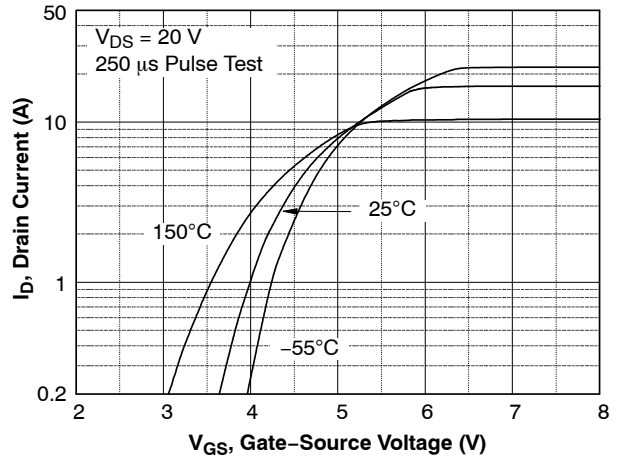


Figure 2. Transfer Characteristics

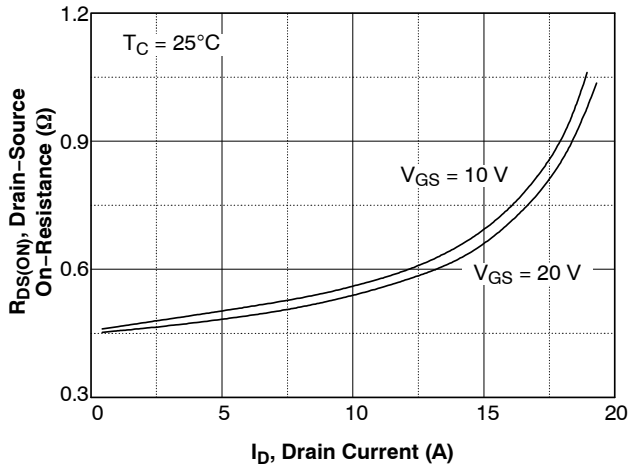


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

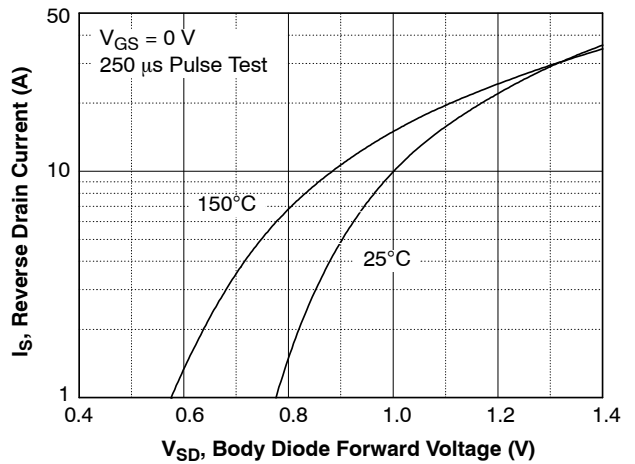


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

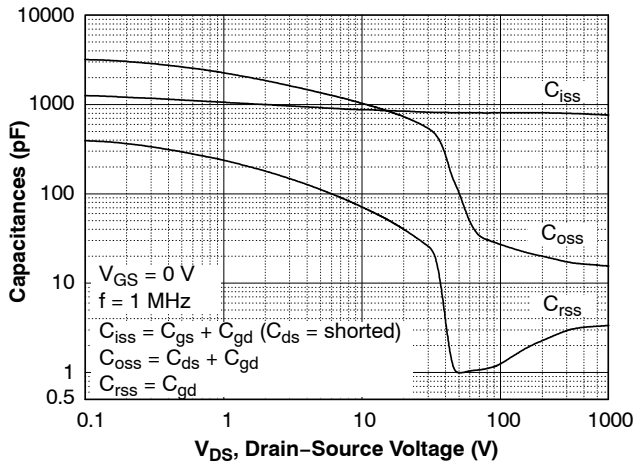


Figure 5. Capacitance Characteristics

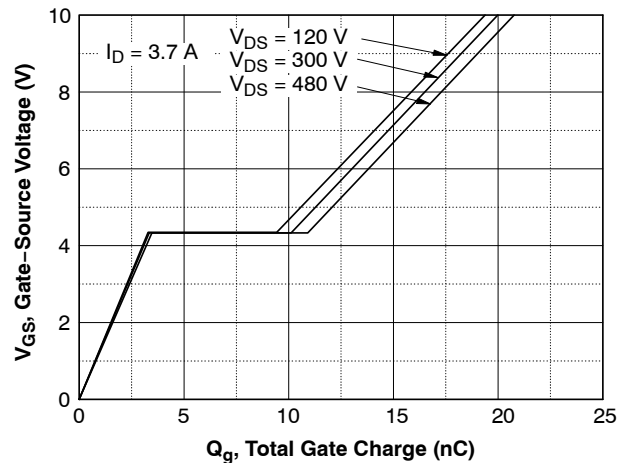
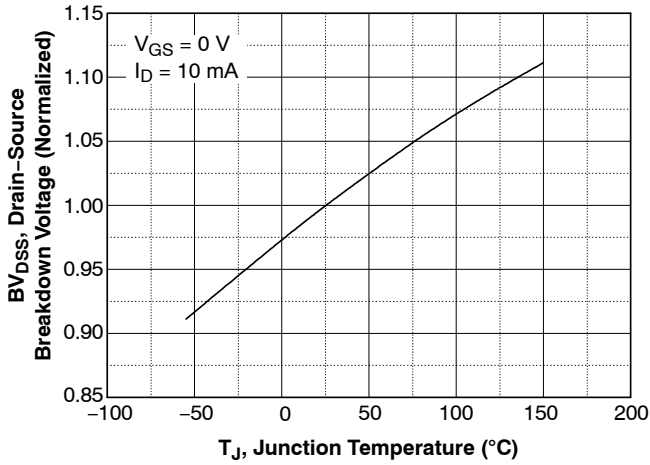


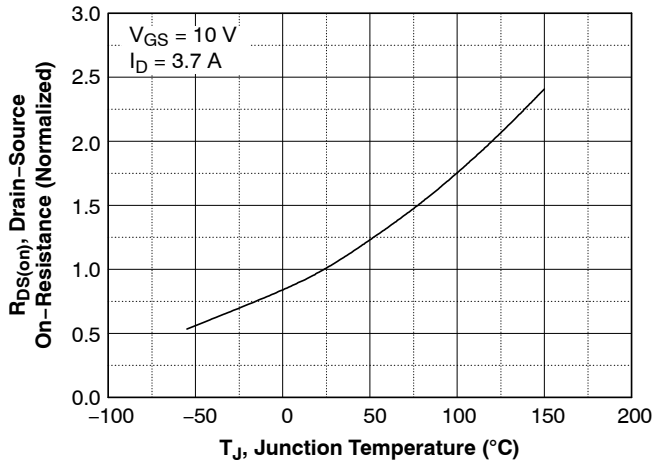
Figure 6. Gate Charge Characteristics

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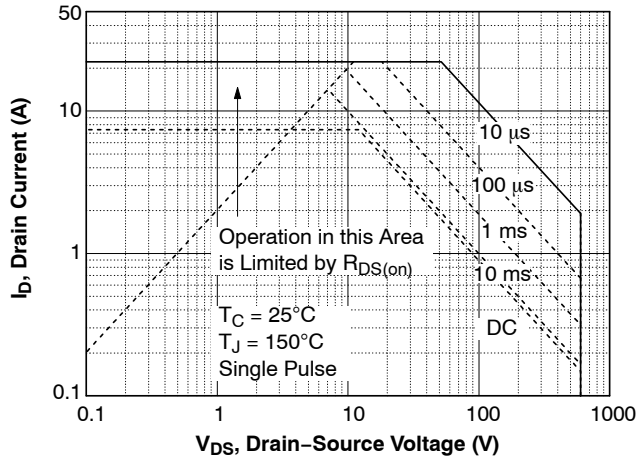
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)



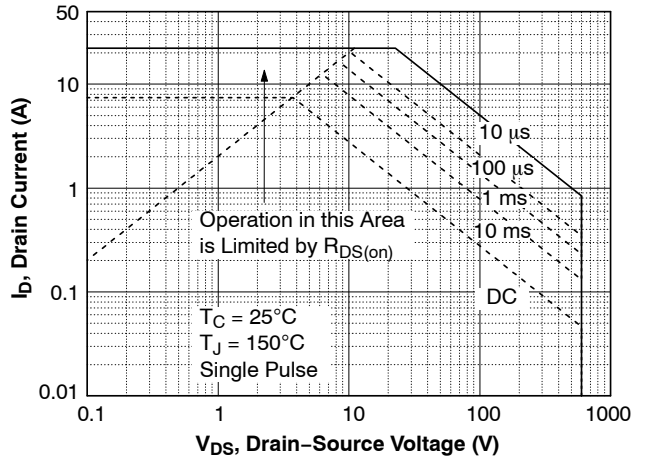
**Figure 7. Breakdown Voltage Variation vs. Temperature**



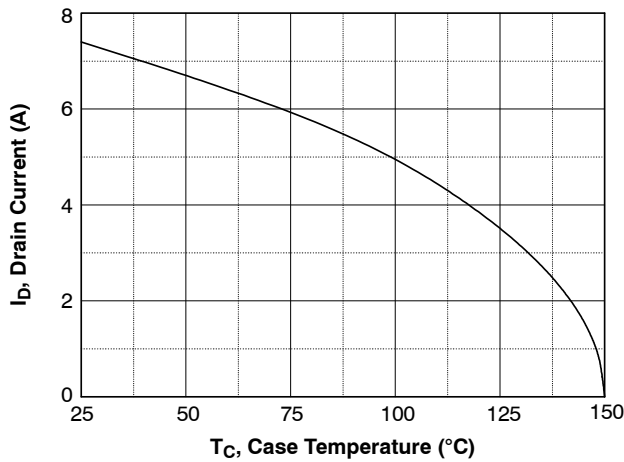
**Figure 8. On-Resistance Variation vs. Temperature**



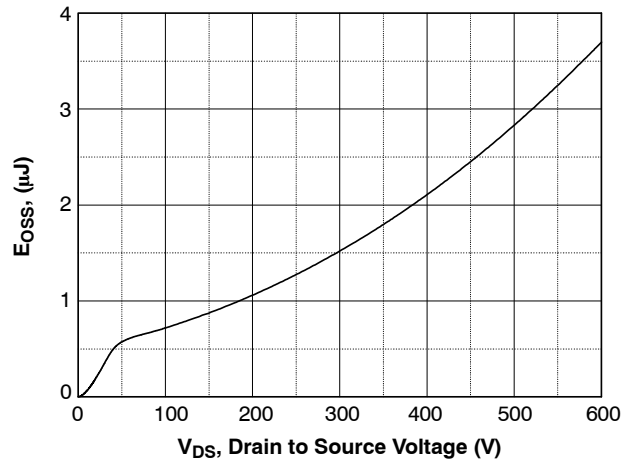
**Figure 9. Maximum Safe Operating Area for FCP600N60Z**



**Figure 10. Maximum Safe Operating Area for FCPF600N60Z**



**Figure 11. Maximum Drain Current vs. Case Temperature**



**Figure 12.  $E_{OSS}$  vs. Drain to Source Voltage**

# FCP600N60Z, FCPF600N60Z

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

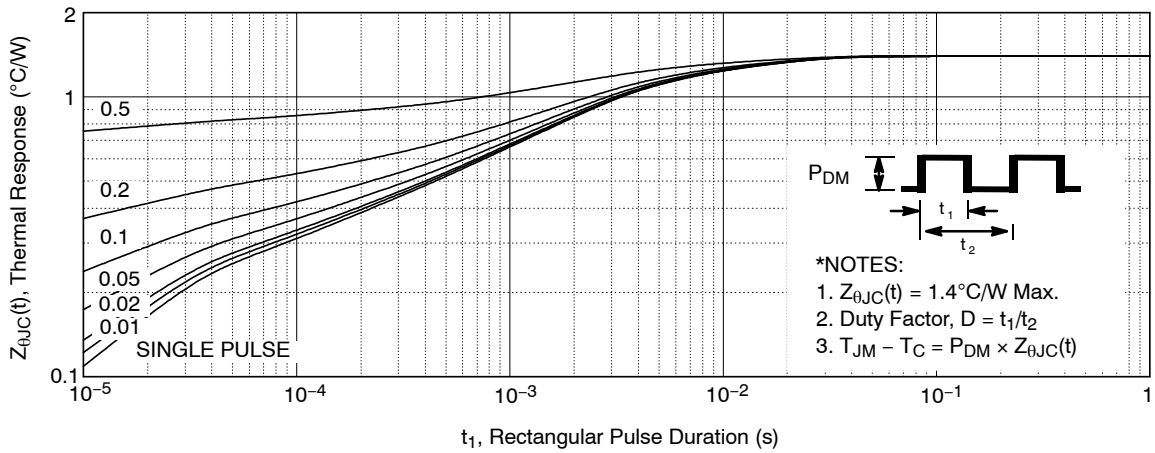


Figure 13. Transient Thermal Response Curve for FCP600N60Z

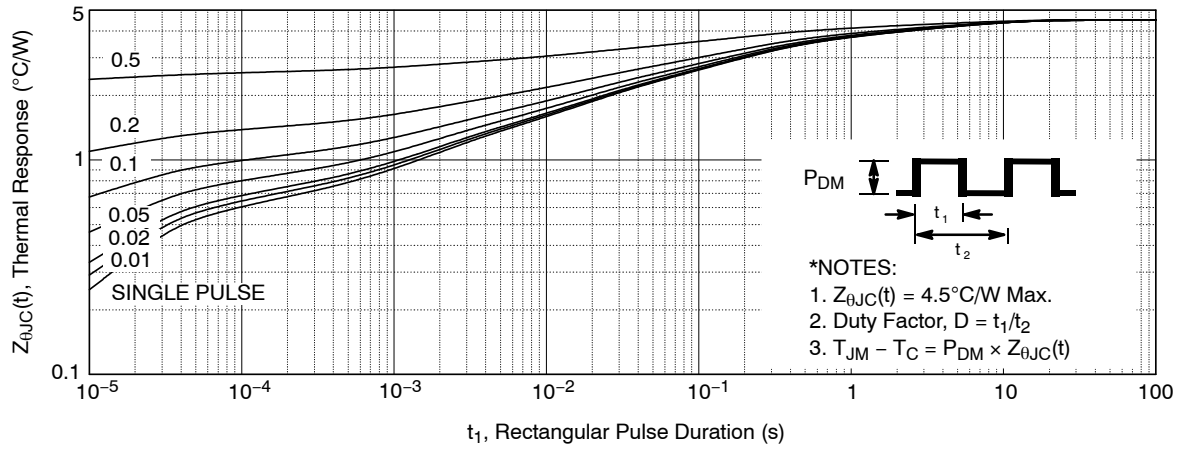


Figure 14. Transient Thermal Response Curve for FCPF600N60Z

# FCP600N60Z, FCPF600N60Z

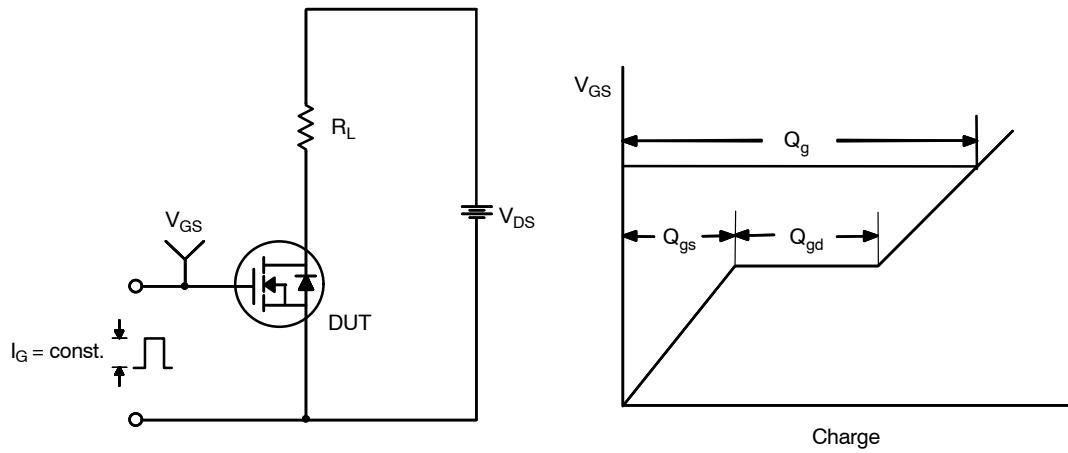


Figure 15. Gate Charge Test Circuit & Waveform

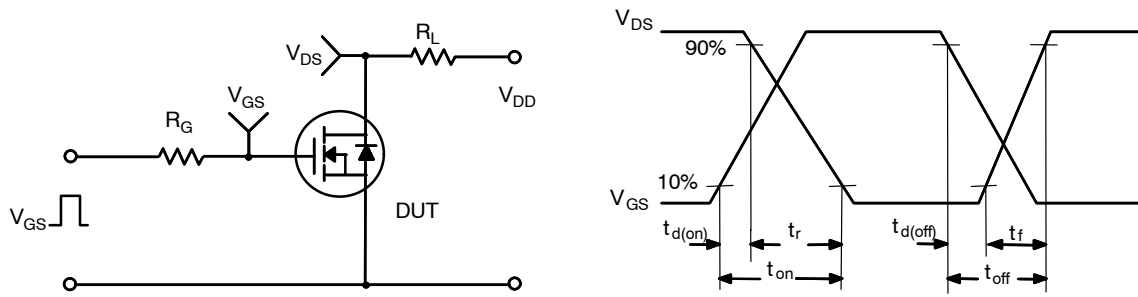


Figure 16. Resistive Switching Test Circuit & Waveforms

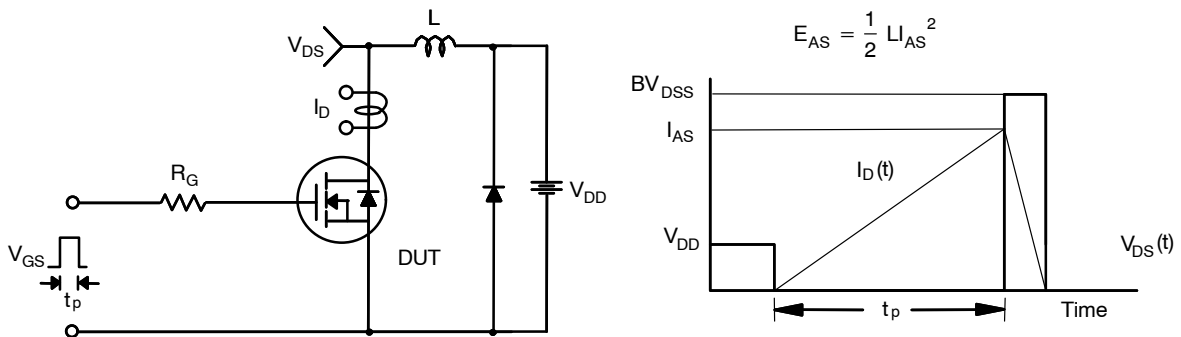
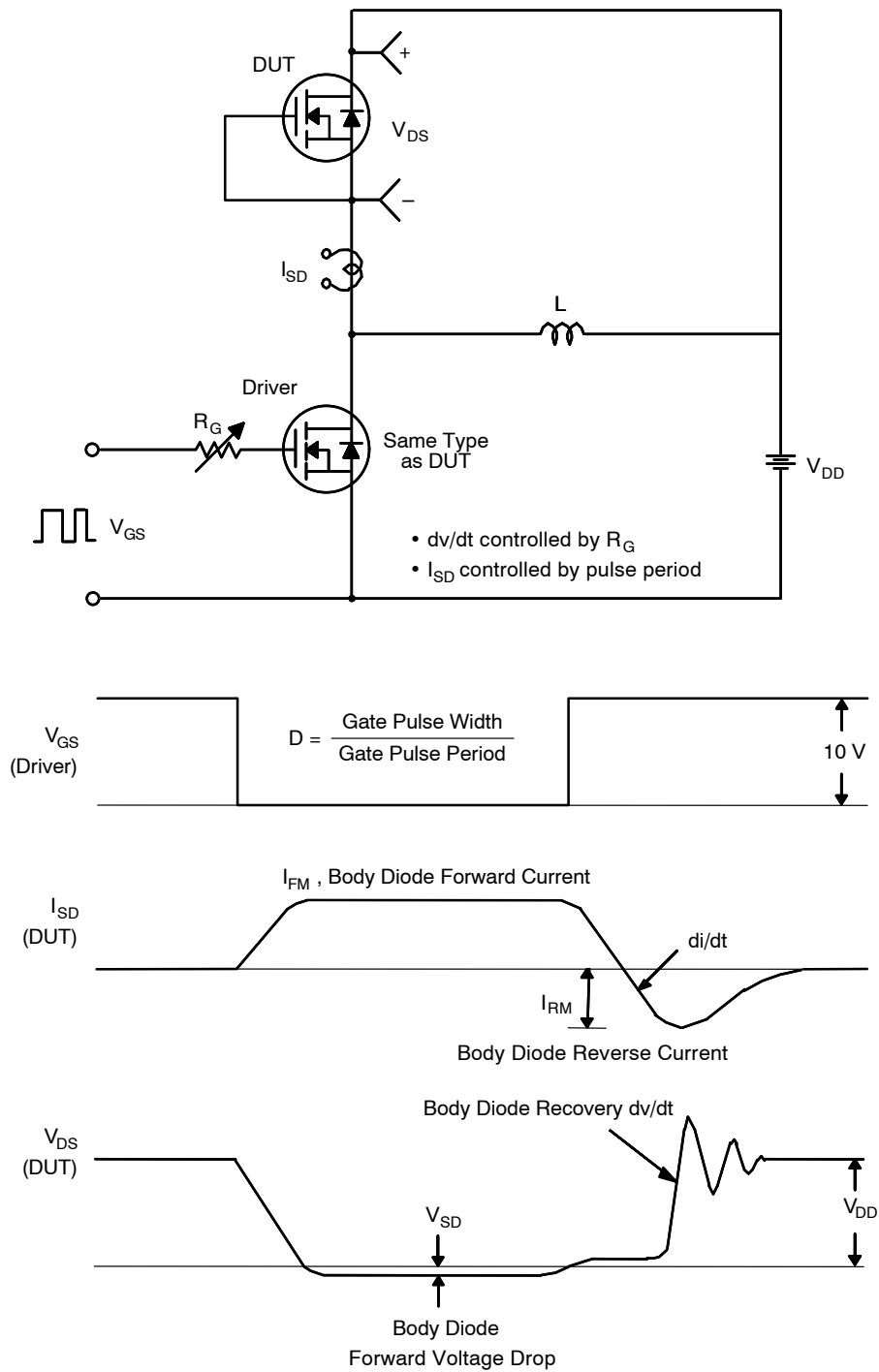


Figure 17. Unclamped Inductive Switching Test Circuit & Waveforms

# FCP600N60Z, FCPF600N60Z



**Figure 18. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**



# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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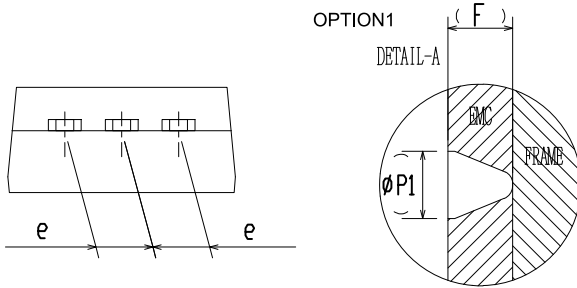
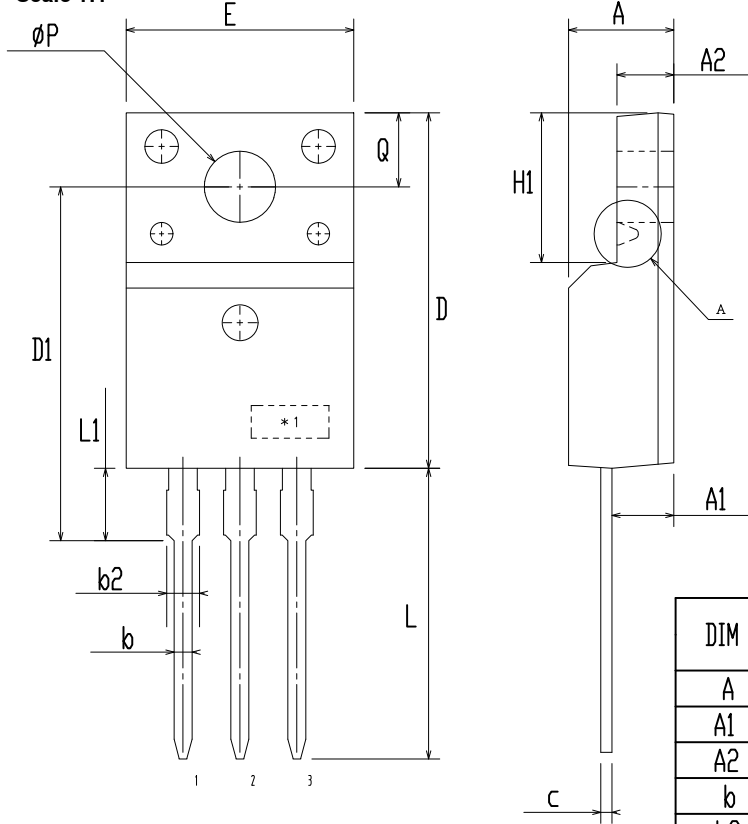


### TO-220 Fullpack, 3-Lead / TO-220F-3SG CASE 221AT ISSUE B

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
∅ P	2.98	3.18	3.38
∅ 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

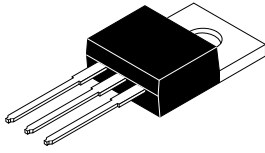
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# MECHANICAL CASE OUTLINE

## 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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