

# MOSFET – N-Channel, SUPERFET® II, Easy-Drive

**600 V, 20.6 A, 190 mΩ**

## FCP190N60E, FCPF190N60E

### 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 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

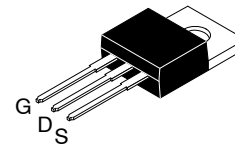
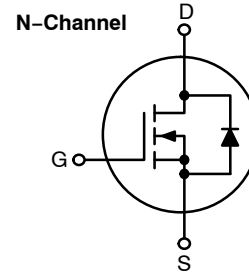
- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 160\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 63\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 178\text{ pF}$ )
- 100% Avalanche Tested
- An Integrated Gate Resistor
- RoHS Compliant

### Applications

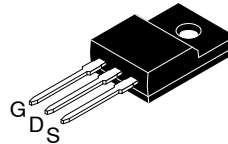
- LCD / LED / PDP TV Lighting
- Solar Inverter
- AC-DC Power Supply

$V_{DS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
600 V	190 mΩ @ 10 V	20.6 A*

\*Drain current limited by maximum junction temperature.

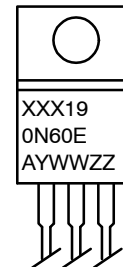


TO-220-3LD  
 CASE 340AT



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

### MARKING DIAGRAM



XXX190N60E = Device Code (XXX = FCP, FCPF)  
 A = Assembly Location  
 YWW = Date Code (Year & Week)  
 ZZ = Assembly Lot

### ORDERING INFORMATION

Device	Package	Shipping
FCP190N60E	TO-220	800 Units / Tube
FCPF190N60E	TO-220F	1000 Units / Tube

## FCP190N60E, FCPF190N60E

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

Symbol	Parameter	FCP190N60E	FCPF190N60E	Unit	
$V_{DSS}$	Drain to Source Voltage	600		V	
$V_{GSS}$	Gate to Source Voltage	-DC	$\pm 20$		
		-AC ( $f > 1$ Hz)	$\pm 30$		
$I_D$	Drain Current	- Continuous ( $T_C = 25^\circ\text{C}$ )	20.6	20.6*	A
		- Continuous ( $T_C = 100^\circ\text{C}$ )	13.1	13.1*	
$I_{DM}$	Drain Current	- Pulsed (Note 1)	61.8	61.8*	A
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)		400		mJ
$I_{AR}$	Avalanche Current (Note 1)		4.0		A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)		2.1		mJ
dv/dt	MOSFET dv/dt		100		V/ns
	Peak Diode Recovery dv/dt (Note 3)		20		
$P_D$	Power Dissipation	( $T_C = 25^\circ\text{C}$ )	208	39	W
		-Derate above $25^\circ\text{C}$	1.67	0.31	W/ $^\circ\text{C}$
$T_J, T_{STG}$	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.  $I_{AS} = 4$  A,  $V_{DD} = 50$  V,  $R_G = 25$   $\Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 10$  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	FCP190N60E	FCPF190N60E	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	0.6	3.2	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	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> = 20 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	–	2.8	–	
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> = 10 A	–	0.16	0.19	Ω
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 10 A	–	20	–	S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	2385	3175	pF
C <sub>oss</sub>	Output Capacitance		–	1795	2396	
C <sub>rss</sub>	Reverse Transfer Capacitance		–	110	165	
C <sub>oss</sub>	Output Capacitance	V <sub>DS</sub> = 380 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	42	–	pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 480 V, V <sub>GS</sub> = 0 V	–	178	–	pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	V <sub>DS</sub> = 380 V, I <sub>D</sub> = 10 A, V <sub>GS</sub> = 10 V (Note 4)	–	63	82	nC
Q <sub>gs</sub>	Gate to Source Gate Charge		–	10	–	
Q <sub>gd</sub>	Gate to Drain "Miller" Charge		–	24	–	
ESR	Equivalent Series Resistance	f = 1 MHz	–	5	–	Ω

### SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>DD</sub> = 300 V, I <sub>D</sub> = 10 A, V <sub>GS</sub> = 10 V, R <sub>G</sub> = 4.7 Ω (Note 4)	–	23	56	ns
t <sub>r</sub>	Turn-On Rise Time		–	14	38	
t <sub>d(off)</sub>	Turn-Off Delay Time		–	101	212	
t <sub>f</sub>	Turn-Off Fall Time		–	15	40	

### DRAIN-SOURCE DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Drain to Source Diode Forward Current	–	–	20.2	A	
I <sub>SM</sub>	Maximum Pulsed Drain to Source Diode Forward Current	–	–	60.6	A	
V <sub>SD</sub>	Drain to Source Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 10 A	–	–	1.2	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 10 A, dI <sub>F</sub> /dt = 100 A/μs	–	308	–	ns
Q <sub>rr</sub>	Reverse Recovery Charge		–	4.8	–	

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.

# FCP190N60E, FCPF190N60E

## TYPICAL PERFORMANCE CHARACTERISTICS

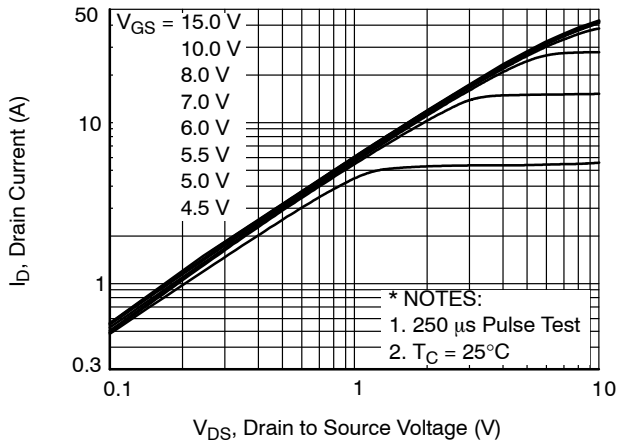


Figure 1. On-Region Characteristics

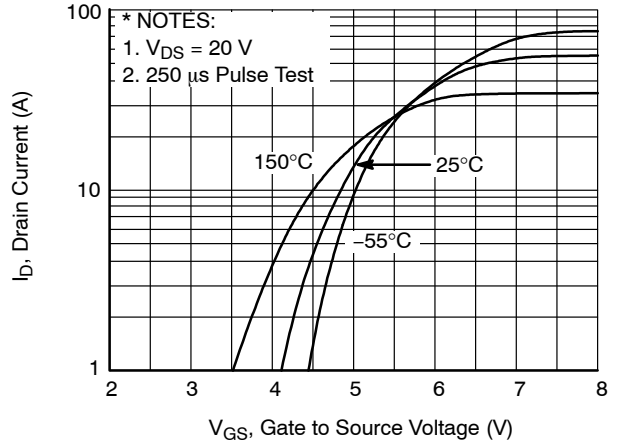


Figure 2. Transfer Characteristics

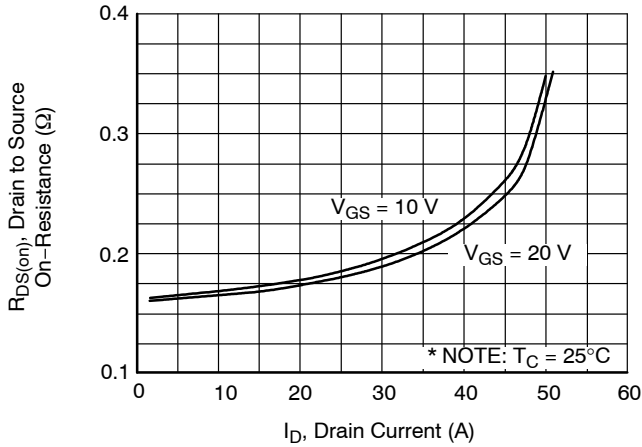


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

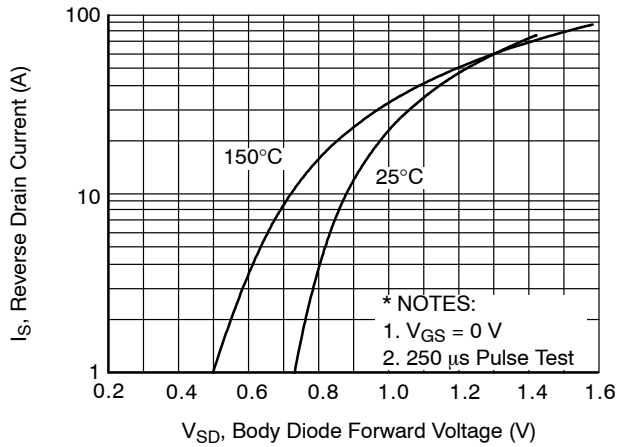


Figure 4. Body Diode Forward Voltage Variation vs. Source Current And Temperature

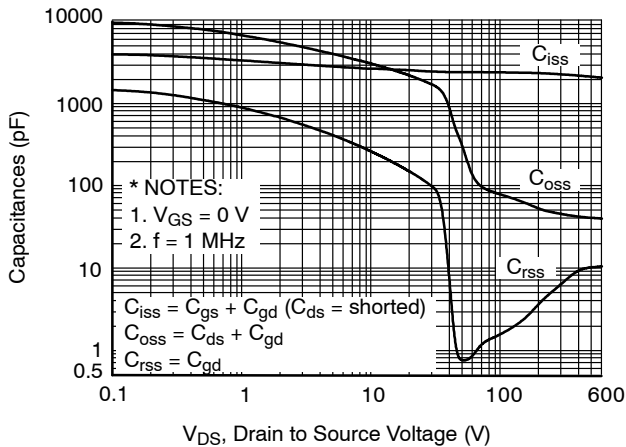


Figure 5. Capacitance Characteristics

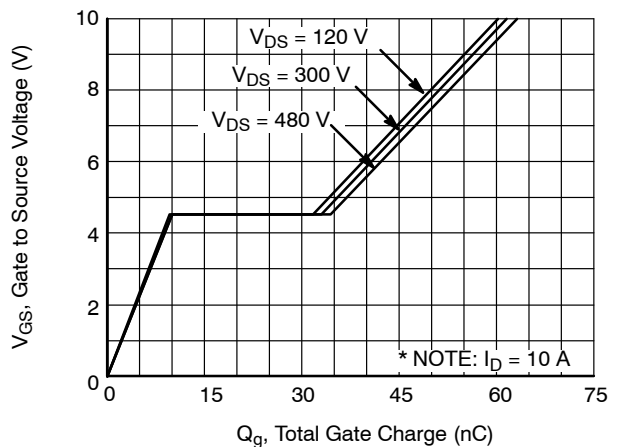
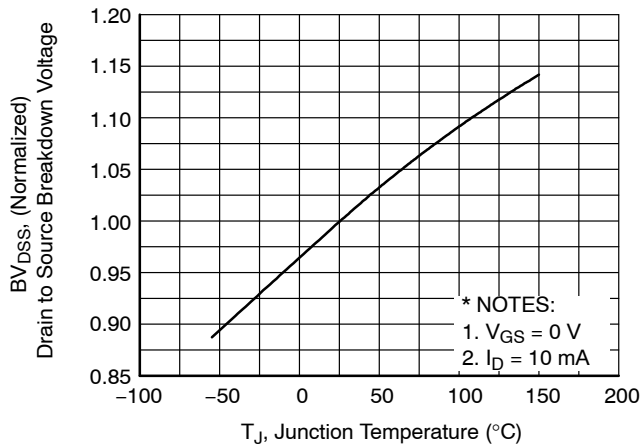


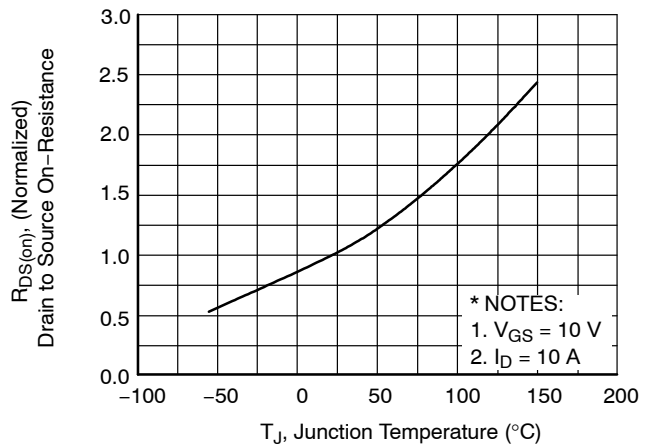
Figure 6. Gate Charge Characteristics

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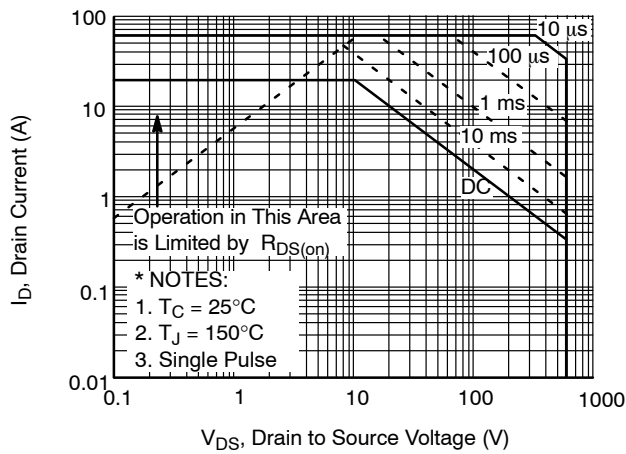
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)



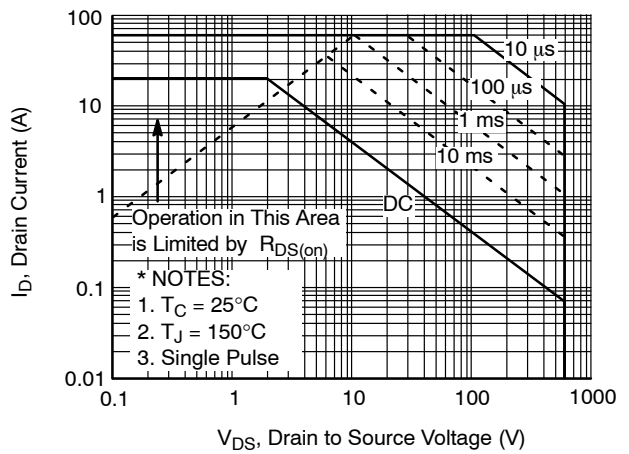
**Figure 7. Breakdown Voltage Variation vs. Temperature**



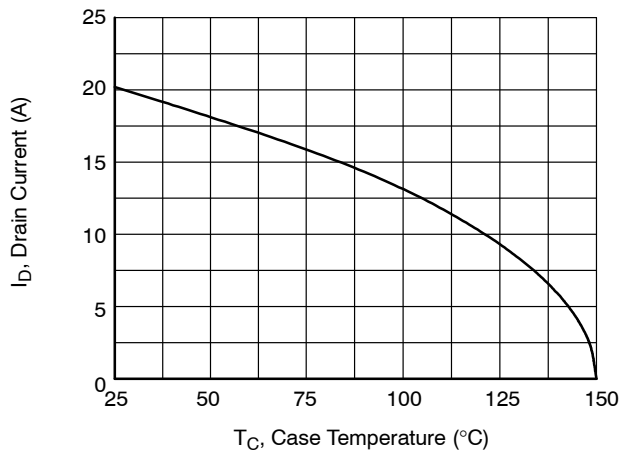
**Figure 8. On-Resistance Variation vs. Temperature**



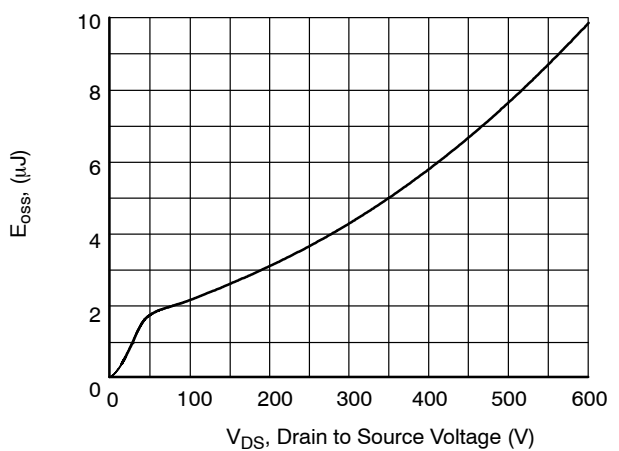
**Figure 9. Maximum Safe Operating Area for FCP190N60E**



**Figure 10. Maximum Safe Operating Area for FCPF190N60E**



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



**Figure 12. E<sub>OSS</sub> vs. Drain to Source Voltage**

# FCP190N60E, FCPF190N60E

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

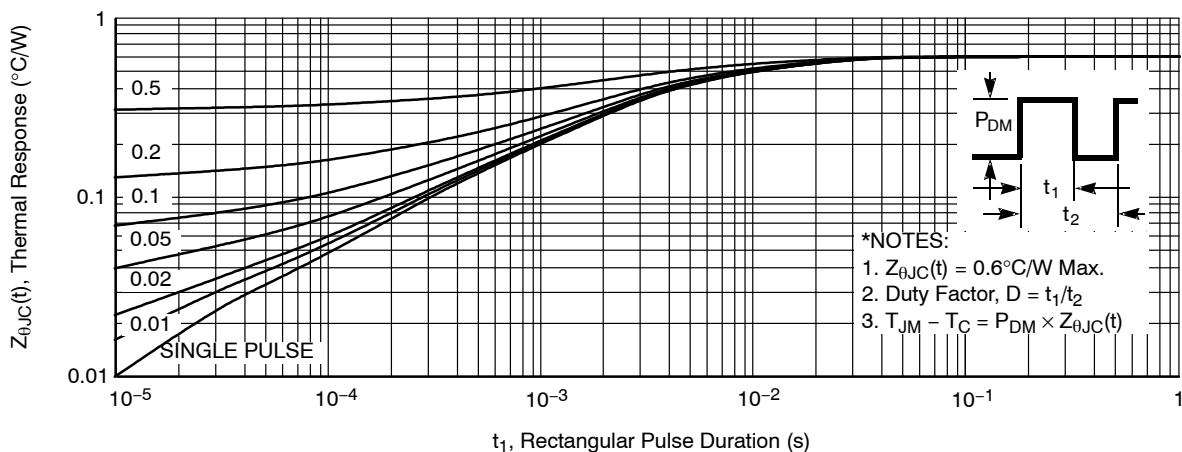


Figure 13. Transient Thermal Response Curve for FCP190N60E

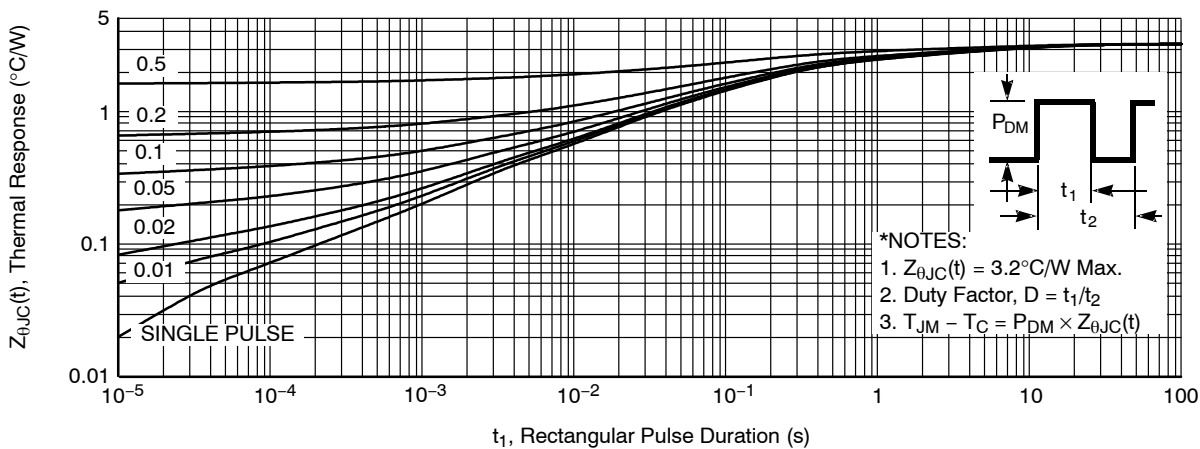


Figure 14. Transient Thermal Response Curve for FCPF190N60E

# FCP190N60E, FCPF190N60E

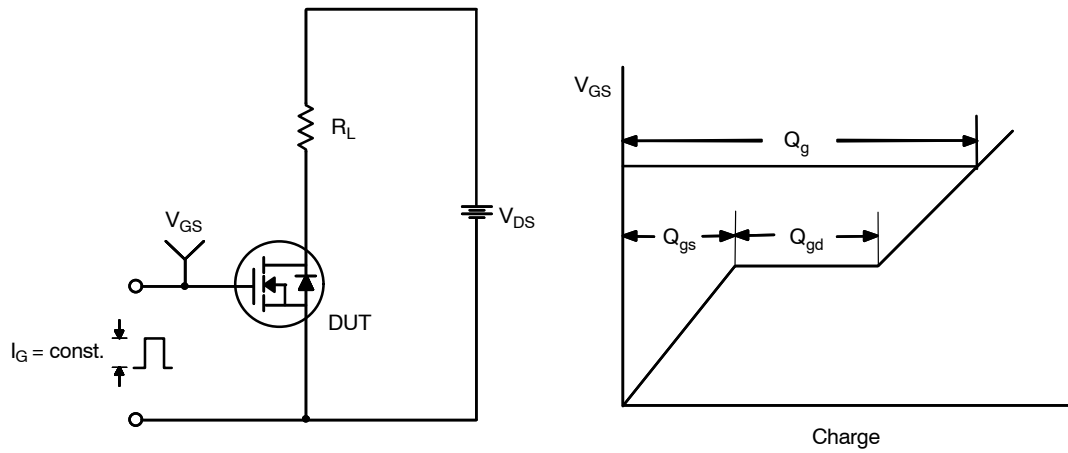


Figure 15. Gate Charge Test Circuit & Waveform

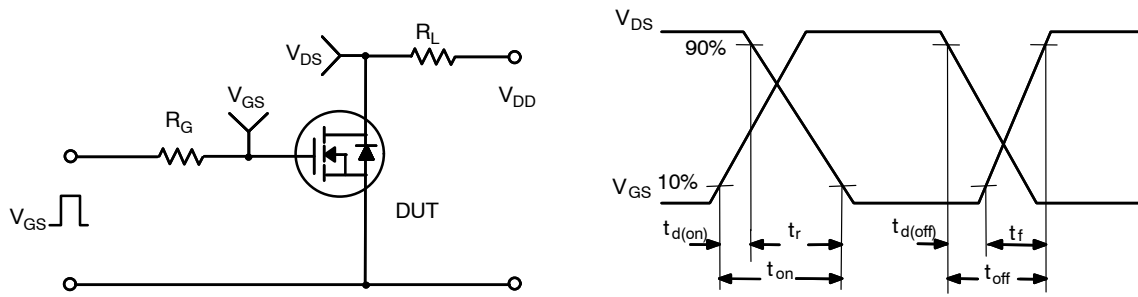


Figure 16. Resistive Switching Test Circuit & Waveforms

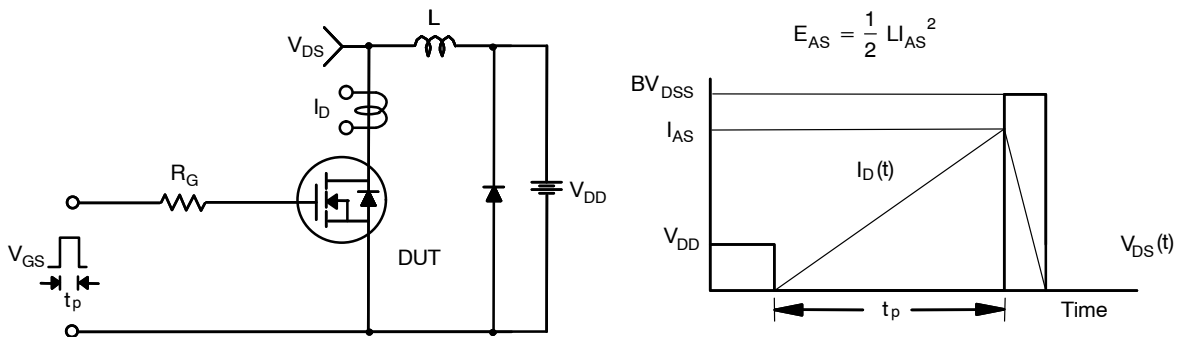
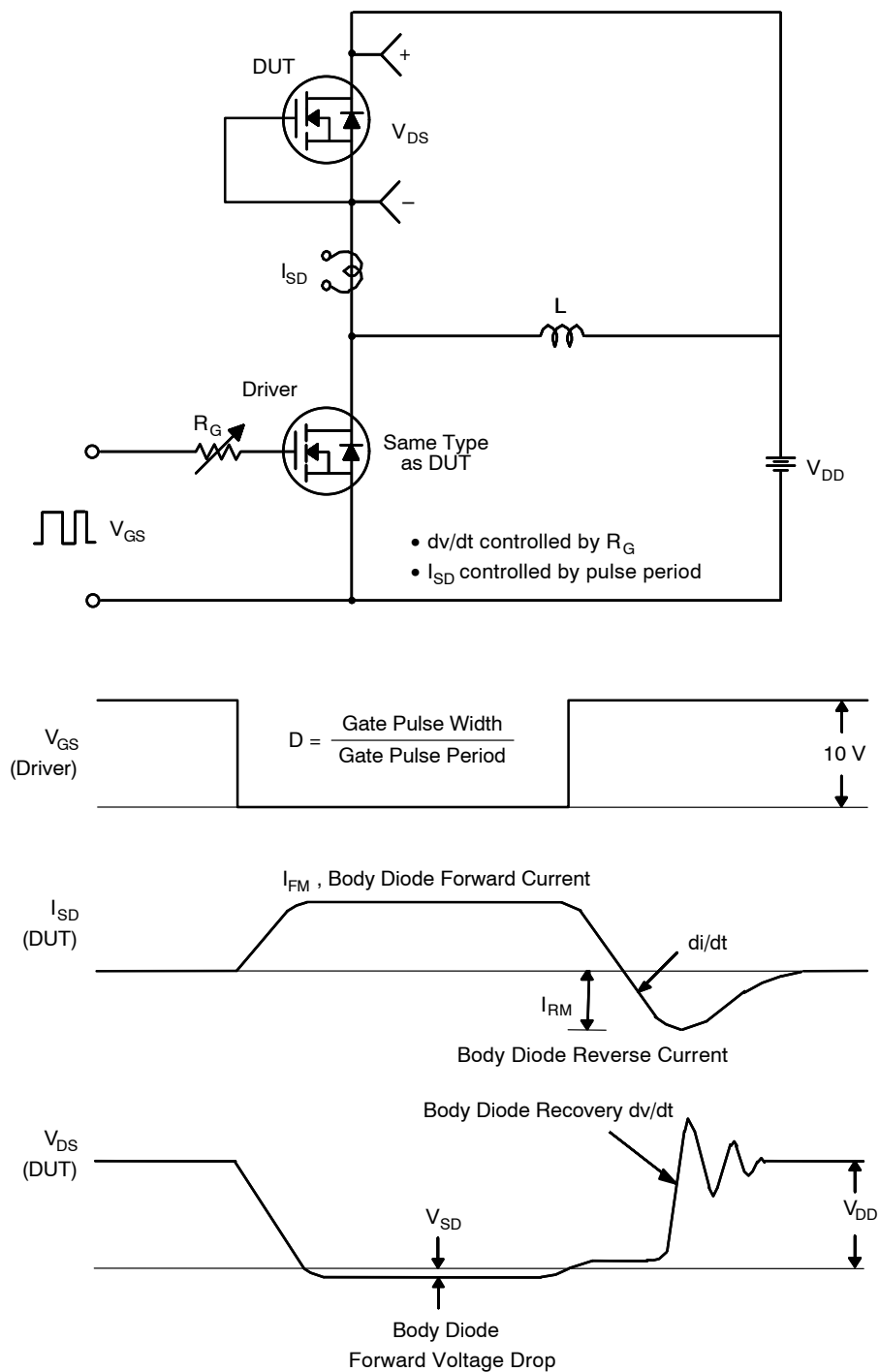


Figure 17. Unclamped Inductive Switching Test Circuit & Waveforms

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

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# MECHANICAL CASE OUTLINE

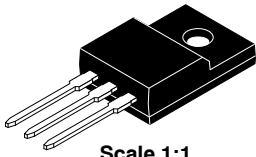
## PACKAGE DIMENSIONS

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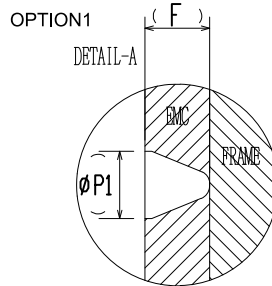
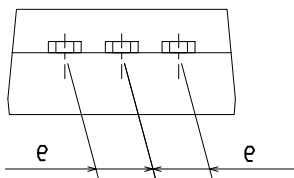
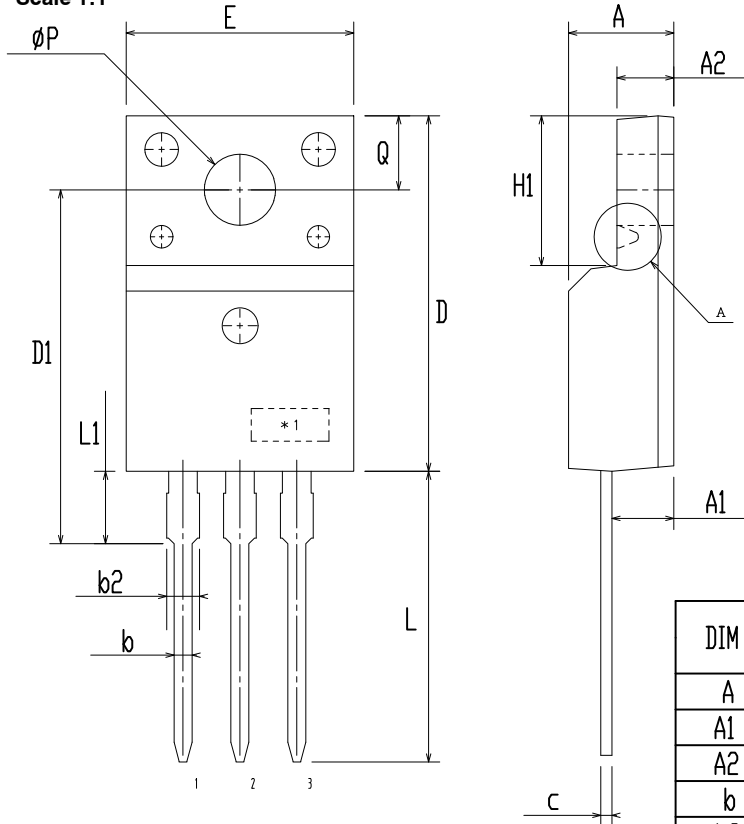


### TO-220 Fullpack, 3-Lead / TO-220F-3SG CASE 221AT ISSUE B

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
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

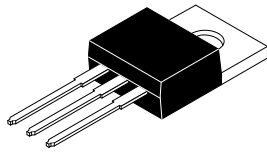
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# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

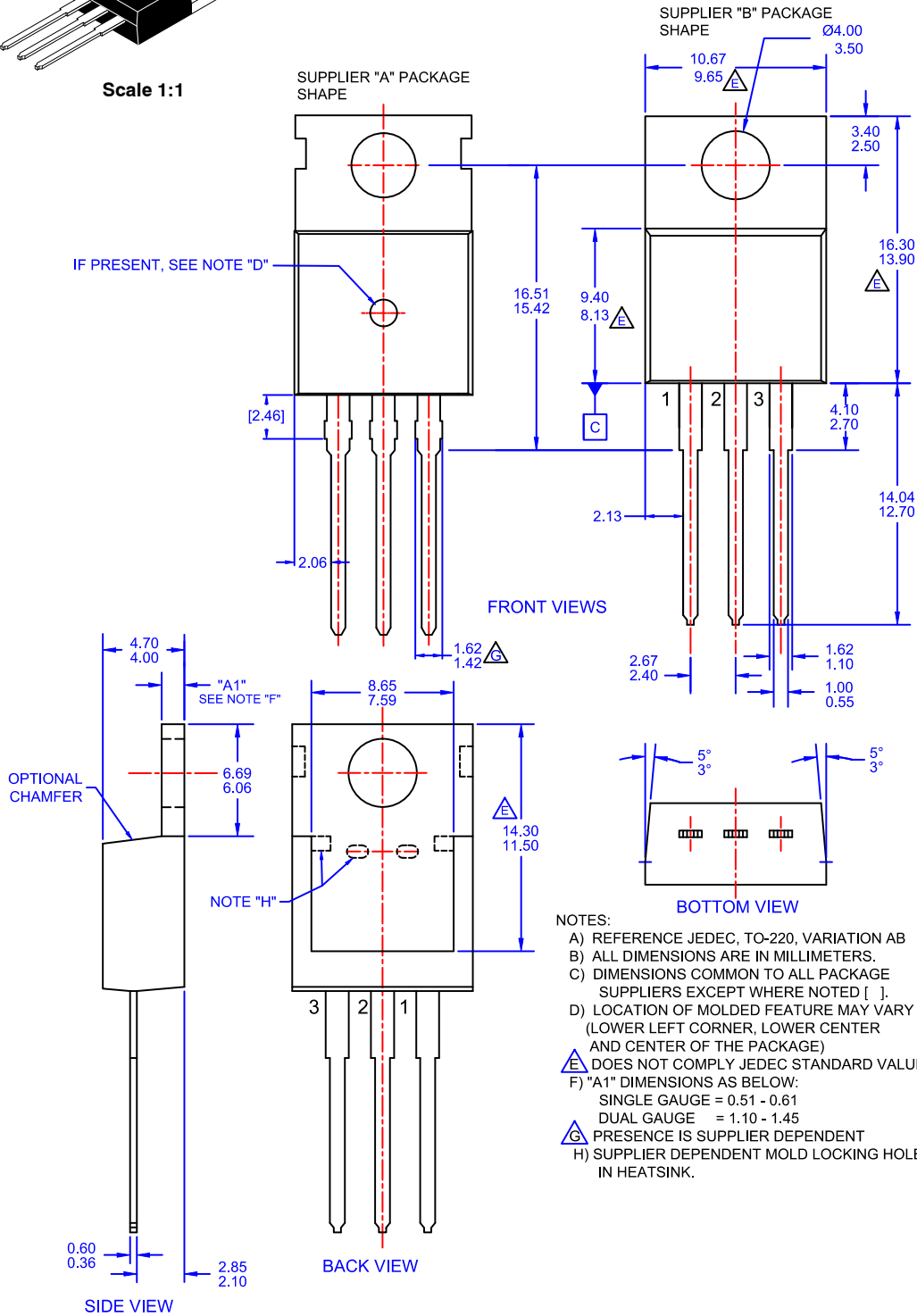
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Scale 1:1

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

DATE 03 OCT 2017



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