

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

**600 V, 10.2 A, 380 mΩ**

## FCP380N60E, FCPF380N60E

### 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.

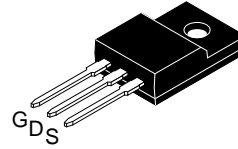
### Features

- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 320\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 34\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 97\text{ pF}$ )
- 100% Avalanche Tested
- An Integrated Gate Resistor
- RoHS Compliant

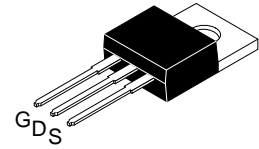
### Applications

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

$V_{DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
600 V	380 mΩ @ 10 V	10.2 A

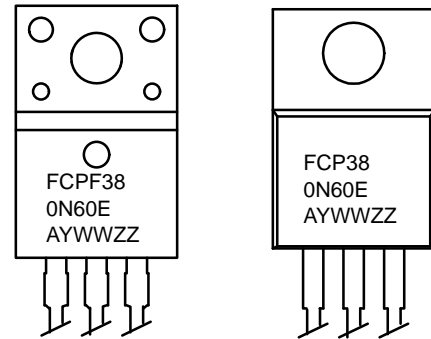


TO-220 Fullpack,  
 3-Lead / TO-220F-3SG  
 CASE 221AT



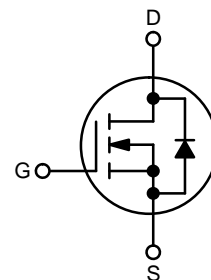
TO-220-3LD  
 CASE 340AT

### MARKING DIAGRAM



FCP380N60E, = Specific Device Code  
 FCPF380N60E  
 A = Assembly Location  
 YWW = Date Code (Year & Week)  
 ZZ = Assembly Lot

### N-CHANNEL MOSFET



### ORDERING INFORMATION

Part Number	Package	Shipping
FCP380N60E	TO-220	800 Units / Tube
FCPF380N60E	TO-220F	1000 Units / Tube

## FCP380N60E, FCPF380N60E

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

Symbol	Parameter		FCP380N60E	FCPF380N60E	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 ( $T_C = 25^\circ\text{C}$ )	10.2	10.2*	A
		- Continuous ( $T_C = 100^\circ\text{C}$ )	6.4	6.4*	
$I_{DM}$	Drain Current	- Pulsed (Note 1)	30.6	30.6*	A
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)		211.6		mJ
$I_{AR}$	Avalanche Current (Note 1)		2.3		A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)		1.06		mJ
dv/dt	MOSFET dv/dt		100		V/ns
	Peak Diode Recovery dv/dt (Note 3)		20		
$P_D$	Power Dissipation	( $T_C = 25^\circ\text{C}$ )	106	31	W
		- Derate Above $25^\circ\text{C}$	0.85	0.25	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.  $I_{AS} = 2.3$  A,  $V_{DD} = 50$  V,  $R_G = 25$   $\Omega$ , starting  $T_J = 25^\circ\text{C}$ .

3.  $I_{SD} \leq 5.1$  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	FCP380N60E	FCPF380N60E	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	1.18	4	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	62.5	62.5	

# FCP380N60E, FCPF380N60E

## 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	–	–	V
ΔBV <sub>DSS</sub> / ΔT <sub>J</sub>	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> = 10 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	–	0.84	–	
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> = 5 A	–	0.32	0.38	Ω
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 20 V, I <sub>D</sub> = 5 A	–	10	–	S

### DYNAMIC CHARACTERISTICS

C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	1330	1770	pF
C <sub>oss</sub>	Output Capacitance		–	945	1260	pF
C <sub>rss</sub>	Reverse Transfer Capacitance		–	60	90	pF
C <sub>oss</sub>	Output Capacitance	V <sub>DS</sub> = 380 V, V <sub>GS</sub> = 0 V, f = 1 MHz	–	25	–	pF
C <sub>oss(eff.)</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 V to 480 V, V <sub>GS</sub> = 0 V	–	97	–	pF
Q <sub>g(tot)</sub>	Total Gate Charge at 10 V	V <sub>DS</sub> = 380 V, I <sub>D</sub> = 5 A, V <sub>GS</sub> = 10 V (Note 4)	–	34	45	nC
Q <sub>gs</sub>	Gate to Source Gate Charge		–	5.3	–	nC
Q <sub>gd</sub>	Gate to Drain "Miller" Charge		–	13	–	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> = 5 A, V <sub>GS</sub> = 10 V, R = 4.7 Ω (Note 4)	–	17	44	ns
t <sub>r</sub>	Turn-On Rise Time		–	9	28	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		–	64	138	ns
t <sub>f</sub>	Turn-Off Fall Time		–	10	30	ns

### DRAIN-SOURCE DIODE CHARACTERISTICS

I <sub>S</sub>	Maximum Continuous Drain to Source Diode Forward Current	–	–	10.2	A	
I <sub>SM</sub>	Maximum Pulsed Drain to Source Diode Forward Current	–	–	30.6	A	
V <sub>SD</sub>	Drain to Source Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 5 A	–	–	1.2	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 5 A, dI <sub>F</sub> /dt = 100 A/μs	–	240	–	ns
Q <sub>rr</sub>	Reverse Recovery Charge		–	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

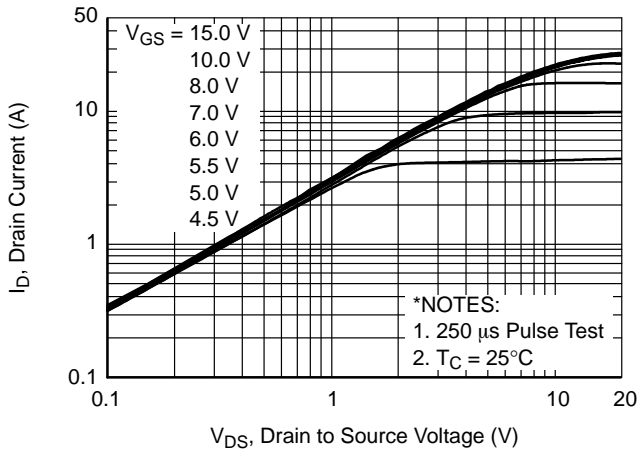


Figure 1. On-Region Characteristics

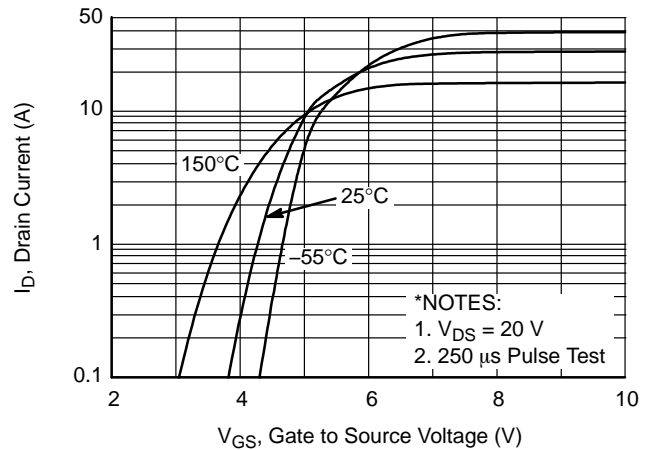


Figure 2. Transfer Characteristics

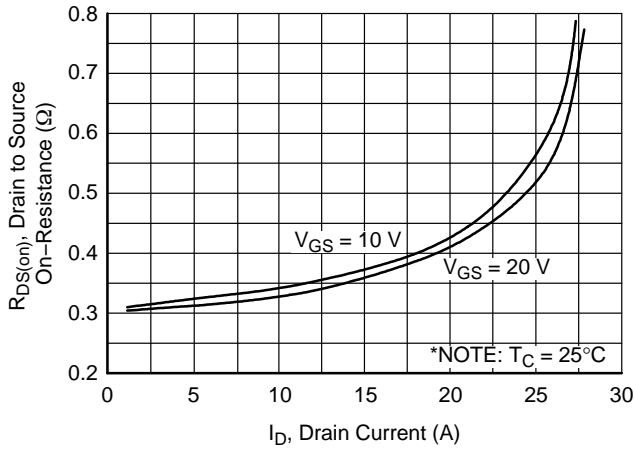


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

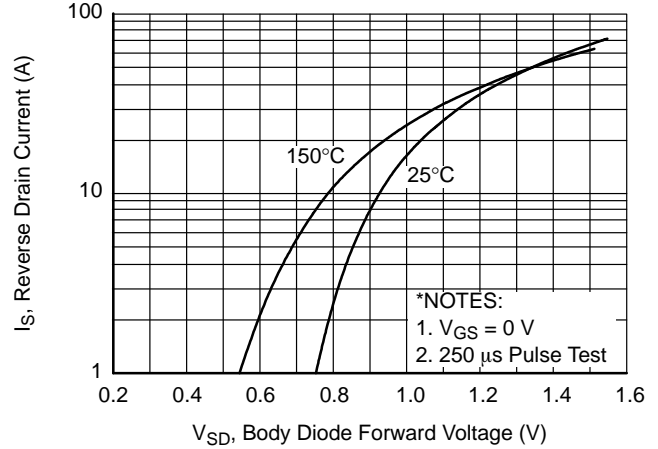


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

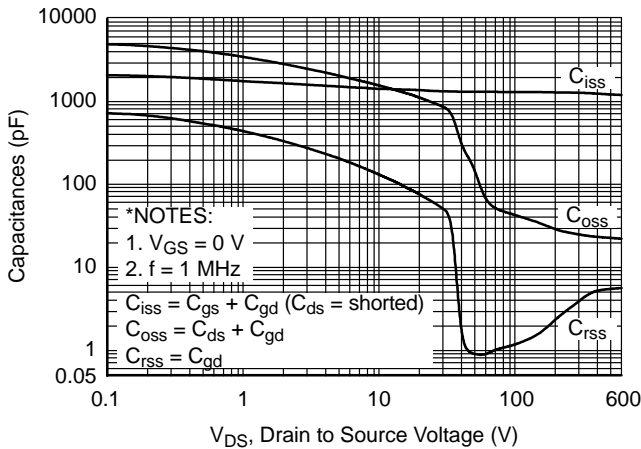


Figure 5. Capacitance Characteristics

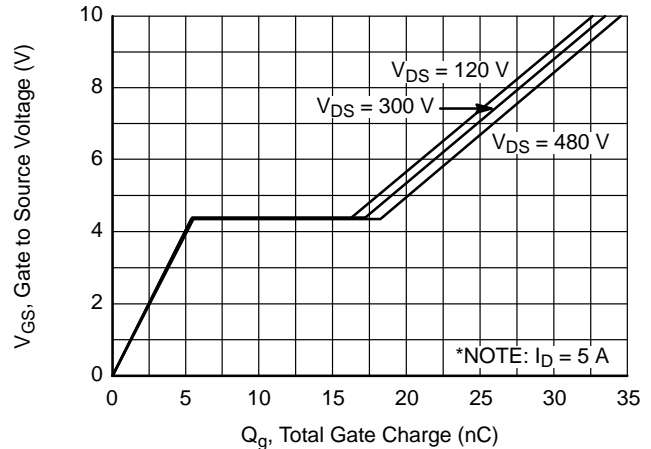
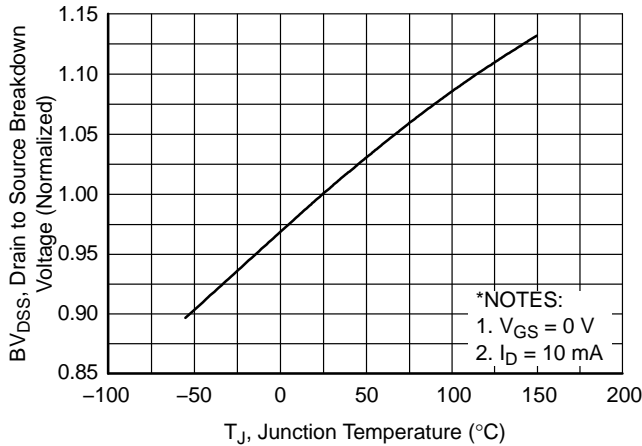


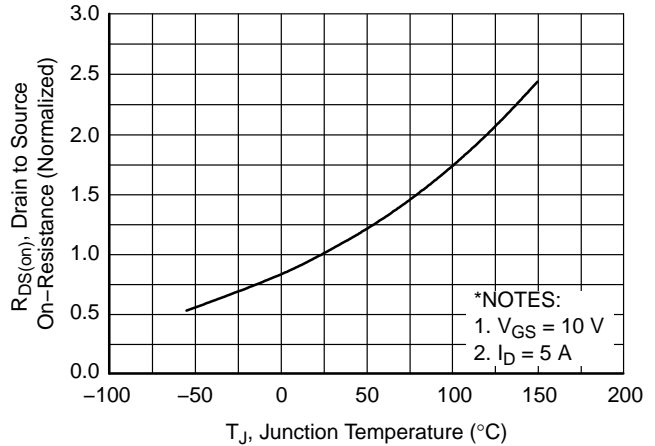
Figure 6. Gate Charge Characteristics

# FCP380N60E, FCPF380N60E

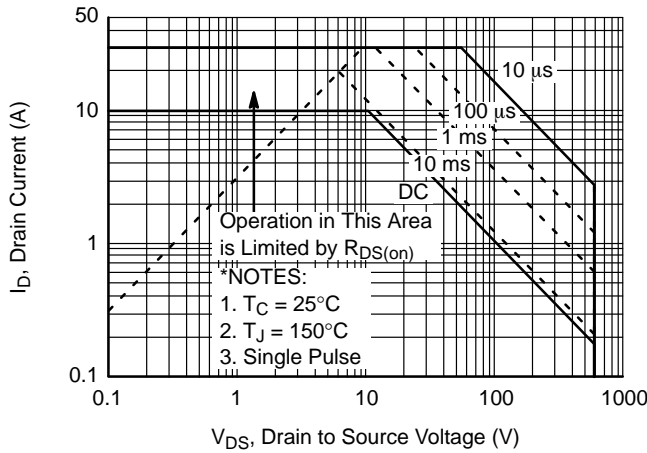
## TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)



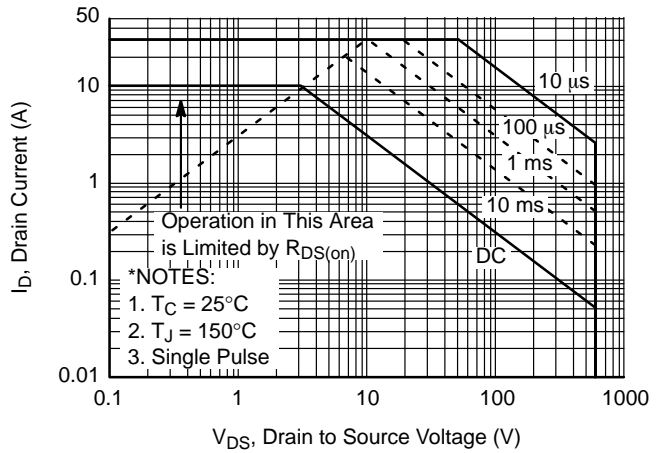
**Figure 7. Breakdown Voltage Variation vs. Temperature**



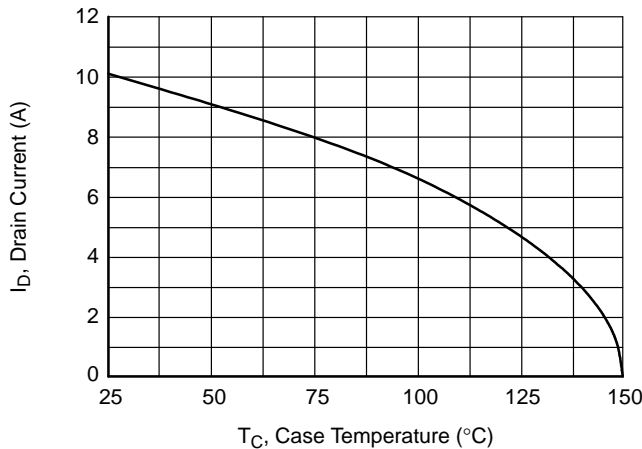
**Figure 8. On-Resistance Variation vs. Temperature**



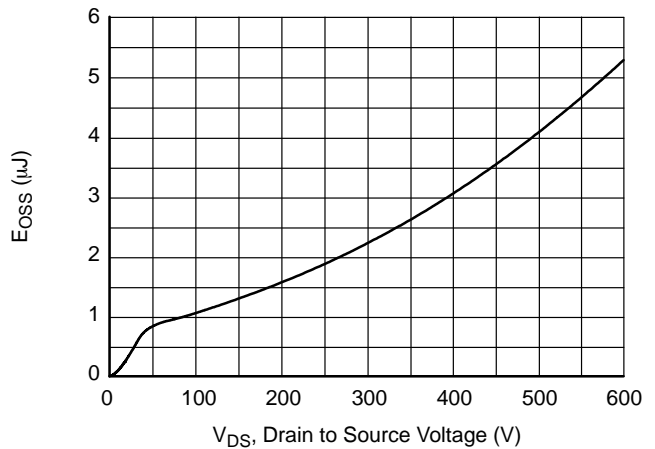
**Figure 9. Maximum Safe Operating Area for FCP380N60E**



**Figure 10. Maximum Safe Operating Area for FCPF380N60E**



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



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

# FCP380N60E, FCPF380N60E

## TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

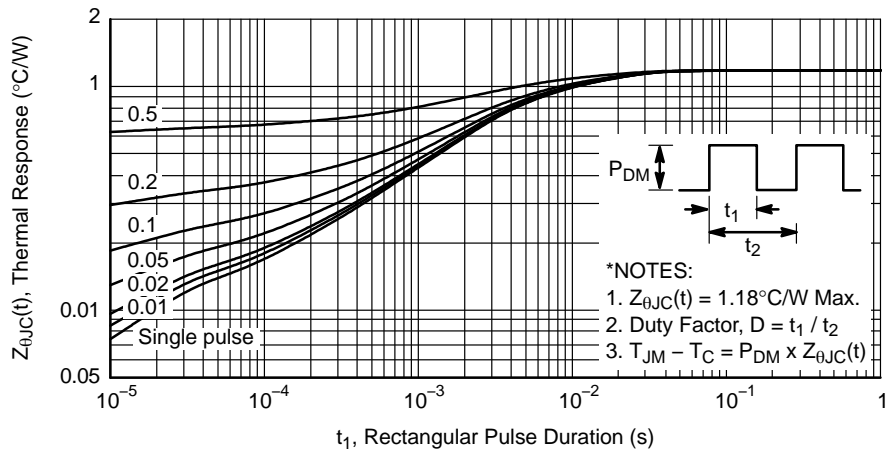


Figure 13. Transient Thermal Response Curve for FCP380N60E

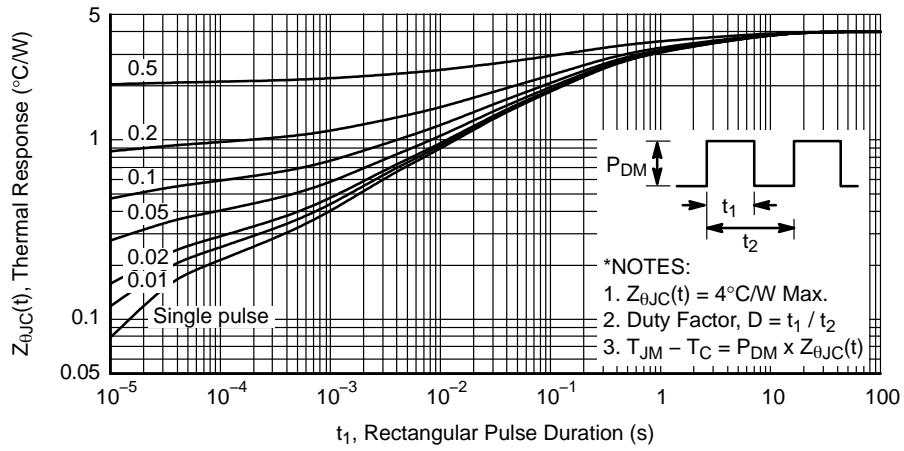


Figure 14. Transient Thermal Response Curve for FCPF380N60E

# FCP380N60E, FCPF380N60E

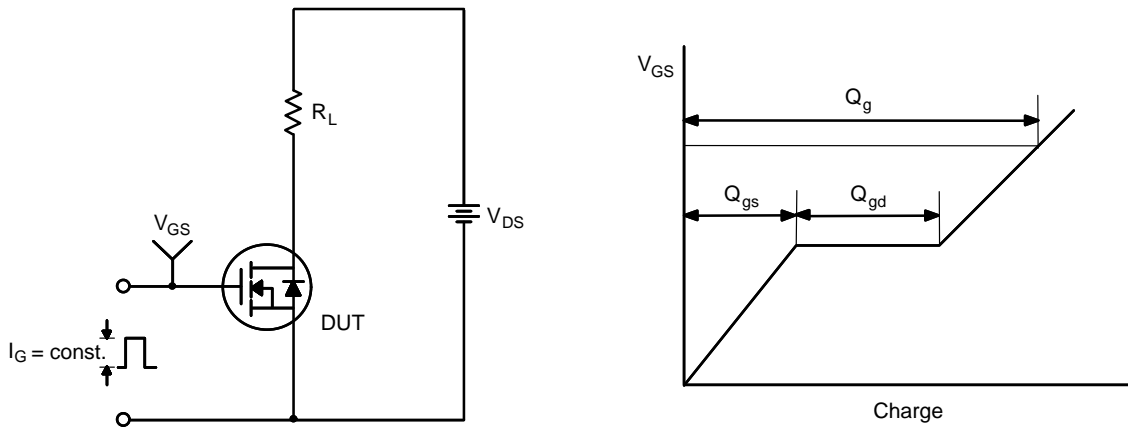


Figure 15. Gate Charge Test Circuit & Waveform

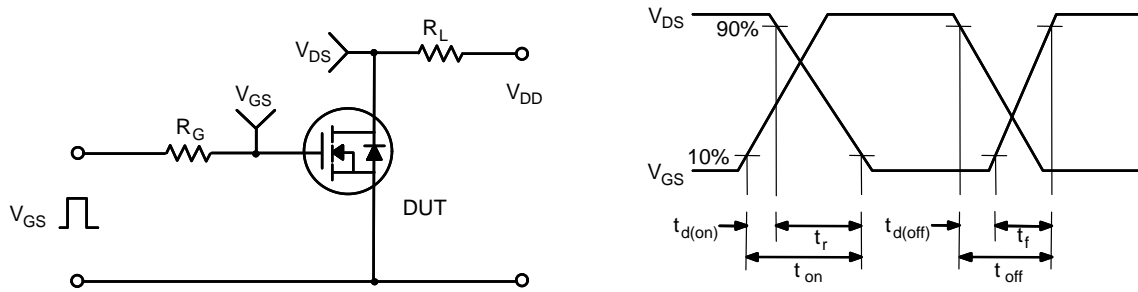


Figure 16. Resistive Switching Test Circuit & Waveforms

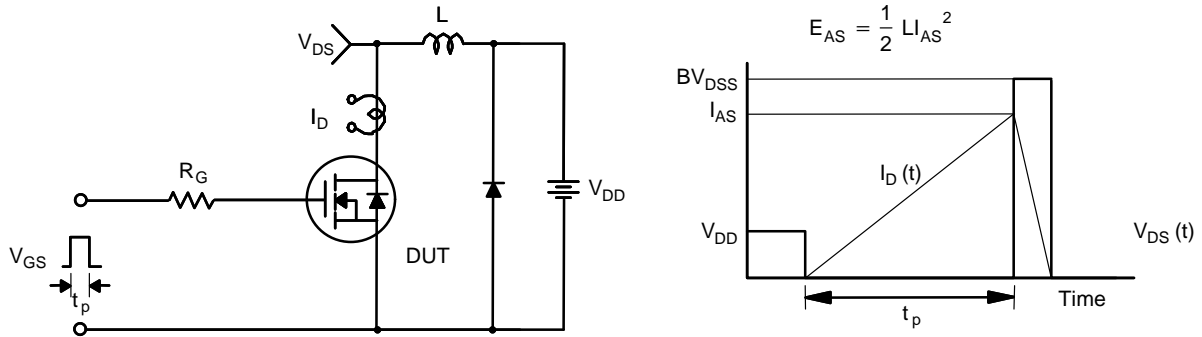
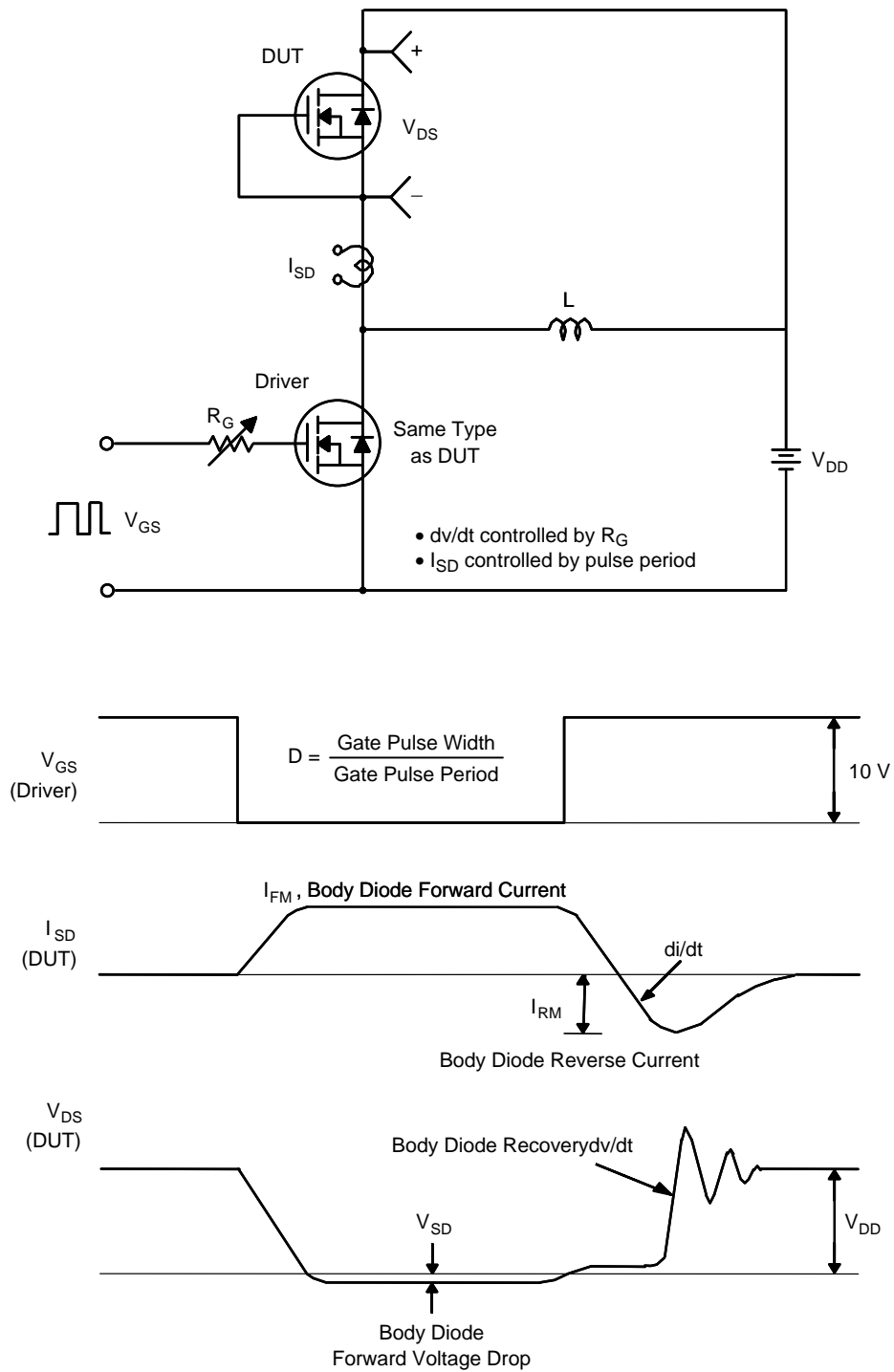


Figure 17. Unclamped Inductive Switching Test Circuit & Waveforms

# FCP380N60E, FCPF380N60E

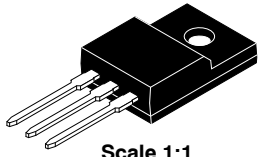


**Figure 18. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**

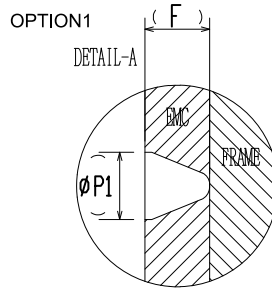
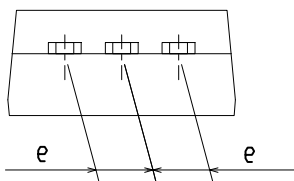


**TO-220 Fullpack, 3-Lead / TO-220F-3SG**  
**CASE 221AT**  
**ISSUE B**

DATE 19 JAN 2021



Scale 1:1



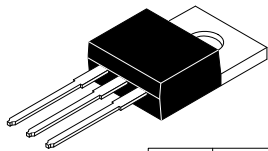
DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.50	4.70	4.90
A1	2.56	2.76	2.96
A2	2.34	2.54	2.74
b	0.70	0.80	0.90
b2	~	~	1.47
c	0.45	0.50	0.60
D	15.67	15.87	16.07
D1	15.60	15.80	16.00
E	9.96	10.16	10.36
e	2.34	2.54	2.74
F	~	0.84	~
H1	6.48	6.68	6.88
L	12.78	12.98	13.18
L1	3.03	3.23	3.43
Ø P	2.98	3.18	3.38
Ø P1	~	1.00	~
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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<b>DESCRIPTION:</b>	<b>TO-220 FULLPACK, 3-LEAD / TO-220F-3SG</b>	<b>PAGE 1 OF 1</b>

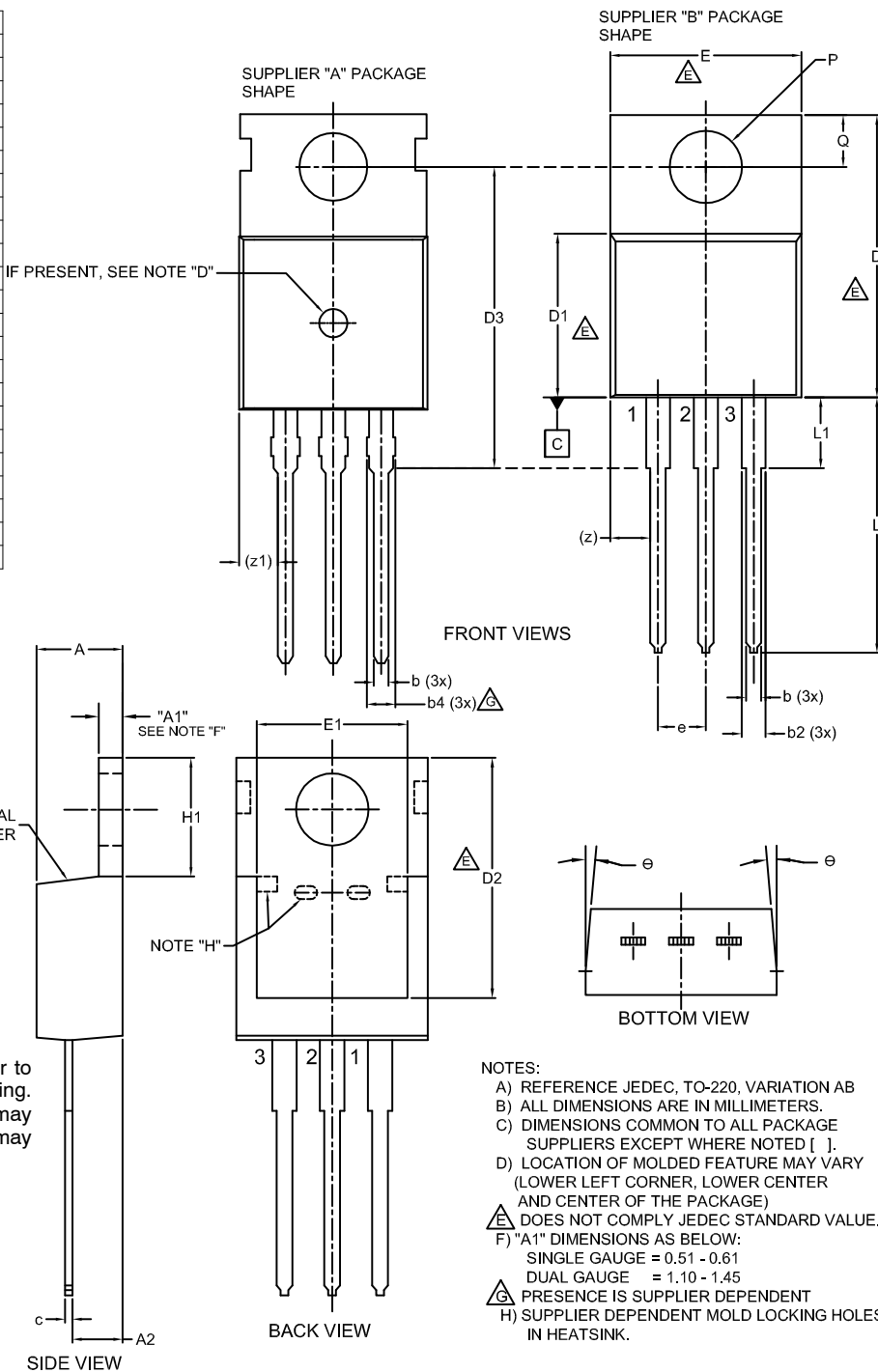
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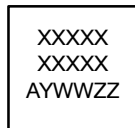
TO-220-3LD  
CASE 340AT  
ISSUE B

DATE 08 AUG 2022

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	4.00	--	4.70
A1	SEE NOTE "F"		
A2	2.10	--	2.85
b	0.55	--	1.00
b2	1.10	--	1.62
b4	1.42	--	1.62
c	0.36	--	0.60
D	13.90	--	16.30
D1	8.13	--	9.40
D2	11.50	--	14.30
D3	15.42	--	16.51
E	9.65	--	10.67
E1	7.59	--	8.65
e	2.40	--	2.67
H1	6.06	--	6.69
L	12.70	--	14.04
L1	2.70	--	4.10
P	3.50	--	4.00
Q	2.50	--	3.40
z	2.13 REF		
z1	2.06 REF		
θ	3°	--	5°



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.

- 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)
  - ⚠ DOES NOT COMPLY JEDEC STANDARD VALUE.
  - F) "A1" DIMENSIONS AS BELOW:  
SINGLE GAUGE = 0.51 - 0.61  
DUAL GAUGE = 1.10 - 1.45
  - ⚠ PRESENCE IS SUPPLIER DEPENDENT
  - H) SUPPLIER DEPENDENT MOLD LOCKING HOLES IN HEATSINK.

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