DATA SHEET
www.onsemi.com

MOSFET – N-Channel, UniFET™ II

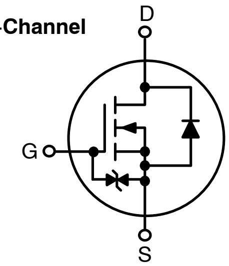
600 V, 12 A, 650 mΩ

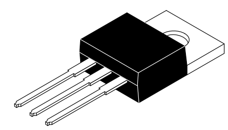
FDP12N60NZ, FDPF12N60NZ

V_{DS}	$R_{DS(ON)}$ MAX	I_D MAX
600 V	650 mΩ @ 10 V	12 A*

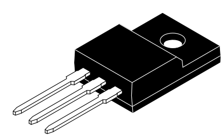
*Drain current limited by maximum junction temperature.

N−Channel





TO−220−3LD
CASE 340AT



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

Description

UniFET II MOSFET is **onsemi**'s high voltage MOSFET family based on advanced planar stripe and DMOS technology. This advanced MOSFET family has the smallest on−state resistance among the planar MOSFET, and also provides superior switching performance and higher avalanche energy strength. In addition, internal gate−source ESD diode allows UniFET II MOSFET to withstand over 2 kV HBM surge stress. This device family is suitable for switching power converter applications such as power factor correction (PFC), flat panel display (FPD) TV power, ATX and electronic lamp ballasts.

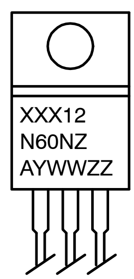
Features

- $R_{DS(on)}$ = 530 mΩ (Typ.) @ V_{GS} = 10 V, I_D = 6 A
- Low Gate Charge (Typ. 26 nC)
- Low C_{rss} (Typ. 12 pF)
- 100% Avalanche Tested
- Improved dv/dt Capability
- ESD Improved Capability
- RoHS Compliant

Applications

- LCD, LED, PDP TV
- Lighting
- Uninterruptible Power Supply

MARKING DIAGRAM



XXX12N60NZ = Device Code (XXX = FDP, FDPF)
A = Assembly Location
YWW = Date Code (Year & Week)
ZZ = Assembly Lot

ORDERING INFORMATION

Device	Package	Shipping
FDP12N60NZ	TO−220	1000 Units / Tube
FDPF12N60NZ	TO−220F	1000 Units / Tube

February, 2024 − Rev. 3

Publication Order Number:
FDPF12N60NZ/D

MOSFET MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Symbol	Parameter		FDP12N60NZ	FDPF12N60NZ	Unit
V_{DSS}	Drain to Source Voltage		600		V
V_{GSS}	Gate to Source Voltage		±30		V
I_D	Drain Current	– Continuous, T_C = 25°C	12	12*	A
		– Continuous, T_C = 100°C	7.2	7.2*	
I_{DM}		– Pulsed (Note 1)	48	48*	
E_{AS}	Single Pulsed Avalanche Energy (Note 2)		565		mJ
I_{AR}	Avalanche Current (Note 1)		12		A
E_{AR}	Repetitive Avalanche Energy (Note 1)		24		mJ
dv/dt	MOSFET dv/dt Ruggedness		20		V/ns
	Peak Diode Recovery dv/dt (Note 3)		10		V/ns
P_D	Power Dissipation	T_C = 25°C	240	39	W
		−Derate above = 25°C	2.0	0.3	W/°C
T_J, T_{STG}	Operating and Storage Temperature Range		−55 to +150		°C
T_L	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.
*Drain current limited by maximum junction temperature.
1. Repetitive rating: pulse−width limited by maximum junction temperature.
2. L = 7.85 mH, I_{AS} = 12 A, V_{DD} = 50 V, R_G = 25 Ω, starting T_J = 25°C.
3. $I_{SD} \le$ 12 A, di/dt ≤ 200 A/μs, $V_{DD} \le BV_{DSS}$, starting T_J = 25°C.

THERMAL CHARACTERISTICS

Symbol	Parameter	FDP12N60NZ	FDPF12N60NZ	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	0.52	3.2	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	62.5	62.5	

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
BV_{DSS}	Drain to Source Breakdown Voltage	I_D = 250 μA, V_{GS} = 0 V, T_J = 25°C	600	–	–	V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	I_D = 250 μA, referenced to 25°C	–	0.6	–	V/°C
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 600 V, V_{GS} = 0 V	–	–	1	μA
		V_{DS} = 480 V, T_C = 125°C	–	–	10	
I_{GSS}	Gate to Body Leakage Current	V_{GS} = ±30 V, V_{DS} = 0 V	–	–	±10	μA
ON CHARACTERISTICS						
$V_{GS(th)}$	Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = 250 μA	3	–	5	V
$R_{DS(on)}$	Static Drain to Source On Resistance	V_{GS} = 10 V, I_D = 6 A	–	0.53	0.65	Ω
g_{FS}	Forward Transconductance	V_{DS} = 20 V, I_D = 6 A	–	13.5	–	S
DYNAMIC CHARACTERISTICS						
C_{iss}	Input Capacitance	V_{DS} = 25 V, V_{GS} = 0 V, f = 1 MHz	–	1260	1676	pF
C_{oss}	Output Capacitance		–	150	200	pF
C_{rss}	Reverse Transfer Capacitance		–	12	18	pF
$Q_{g(tot)}$	Total Gate Charge at 10 V	V_{DS} = 480 V, I_D = 12 A, V_{GS} = 10 V (Note 4)	–	26	34	nC
Q_{gs}	Gate to Source Gate Charge		–	6	–	nC
Q_{gd}	Gate to Drain “Miller” Charge		–	10	–	nC
SWITCHING CHARACTERISTICS						
$t_{d(on)}$	Turn−On Delay Time	V_{DD} = 300 V, I_D = 12 A, V_{GS} = 10 V, R_G = 25 Ω (Note 4)	–	25	60	ns
t_r	Turn−On Rise Time		–	50	110	ns
$t_{d(off)}$	Turn−Off Delay Time		–	80	170	ns
t_f	Turn−Off Fall Time		–	60	130	ns
DRAIN−SOURCE DIODE CHARACTERISTICS						
I_S	Maximum Continuous Drain to Source Diode Forward Current		–	–	12	A
I_{SM}	Maximum Pulsed Drain to Source Diode Forward Current		–	–	48	A
V_{SD}	Drain to Source Diode Forward Voltage	V_{GS} = 0 V, I_{SD} = 12 A	–	–	1.4	V
t_{rr}	Reverse Recovery Time	V_{GS} = 0 V, I_{SD} = 12 A, dI_F/dt = 100 A/μs	–	350	–	ns
Q_{rr}	Reverse Recovery Charge		–	2.2	–	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 (T_J = 25°C unless otherwise noted)

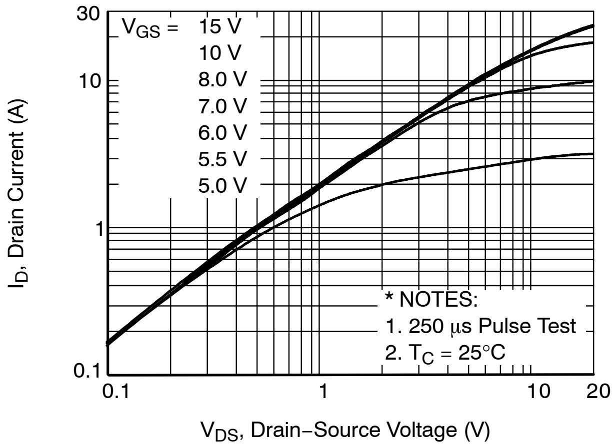


Figure 1. On−Region Characteristics

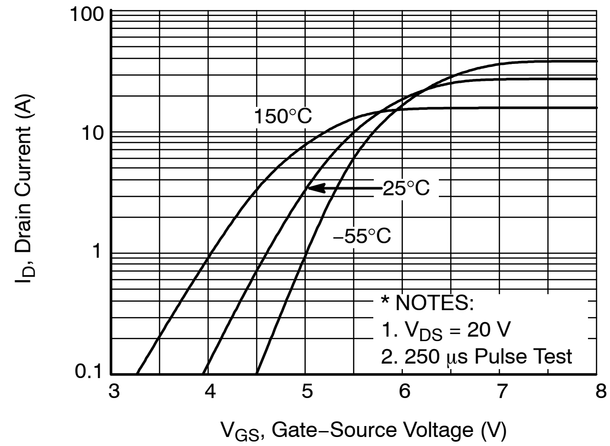


Figure 2. Transfer Characteristics

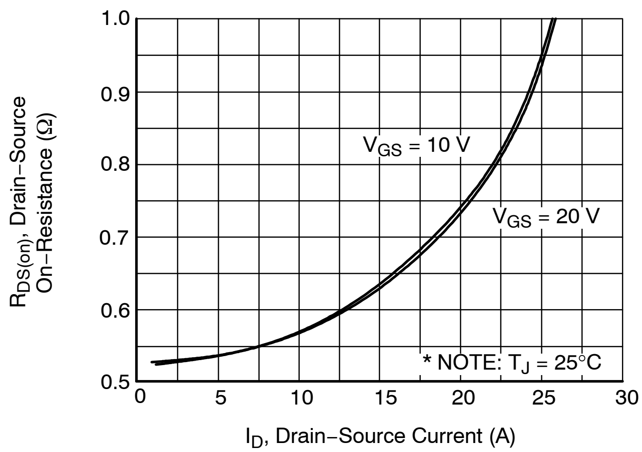


Figure 3. On−Resistance Variation vs. Drain Current and Gate Voltage

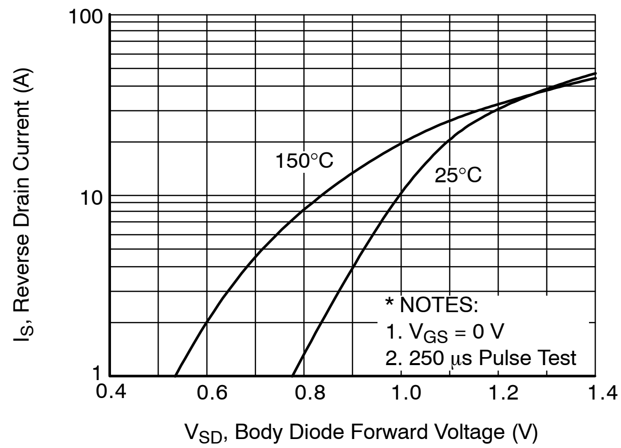


Figure 4. Body Diode Forward Voltage Variation vs. Source Current And Temperature

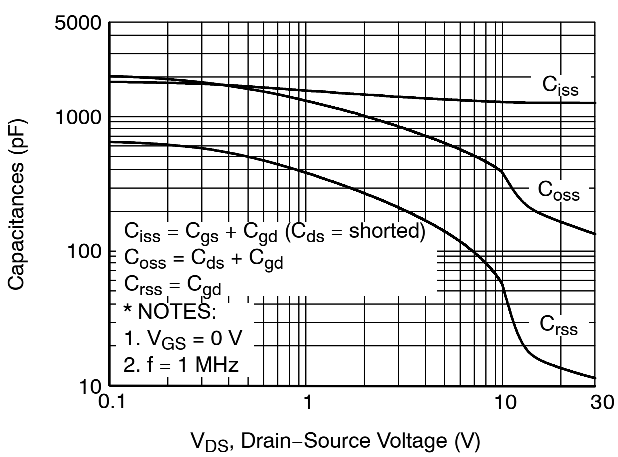


Figure 5. Capacitance Characteristics

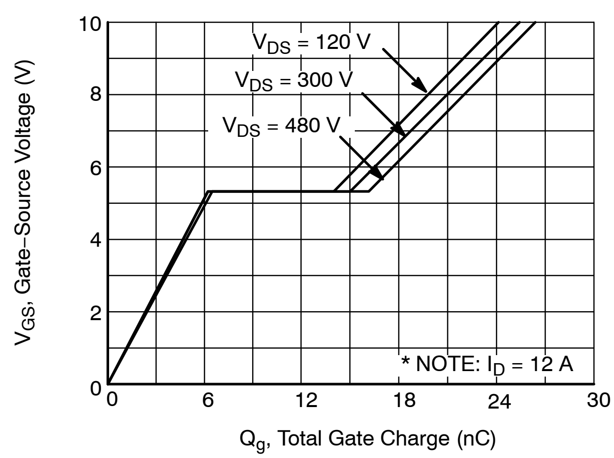


Figure 6. Gate Charge Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

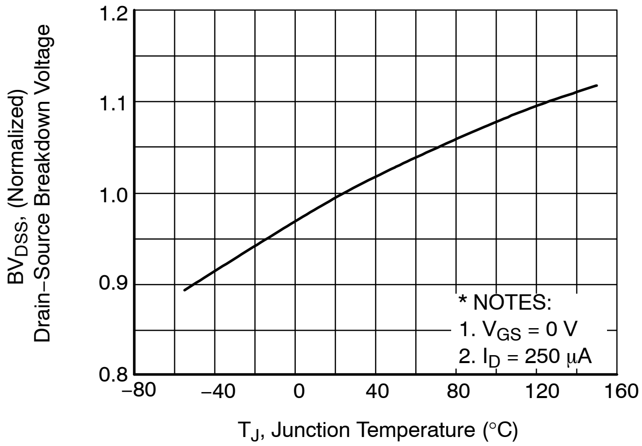


Figure 7. Breakdown Voltage Variation vs. Temperature

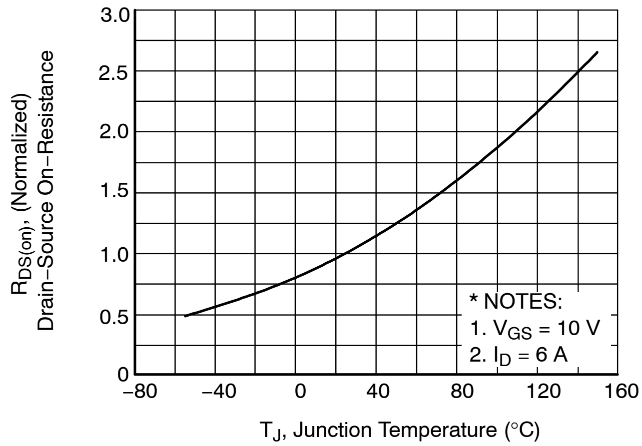


Figure 8. On−Resistance Variation vs. Temperature

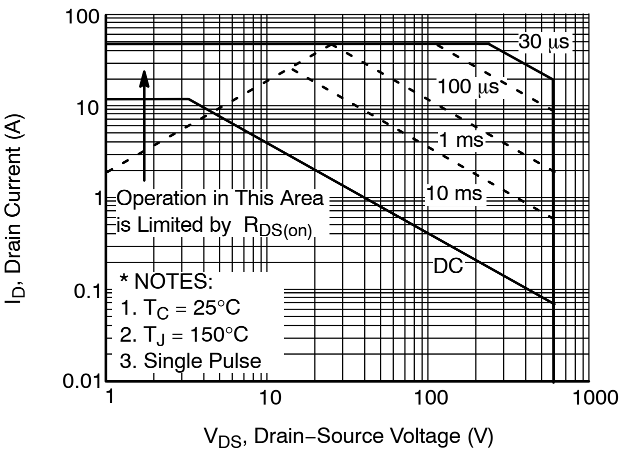


Figure 9. Maximum Safe Operating Area − FDPF12N60NZ

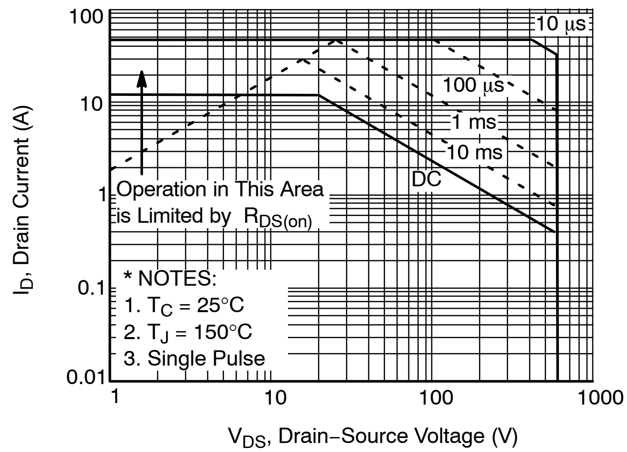


Figure 10. Maximum Safe Operating Area − FDP12N60NZ

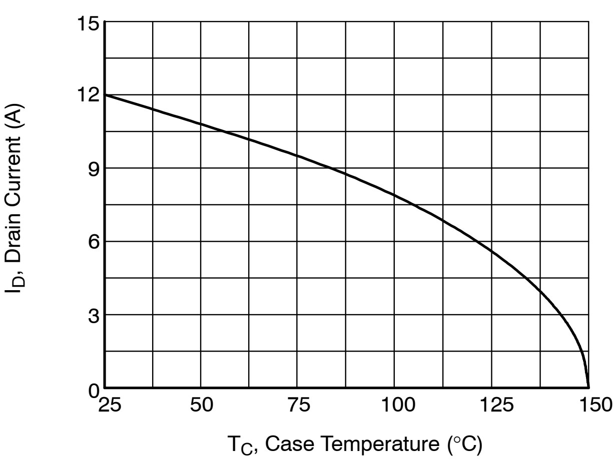


Figure 11. Maximum Drain Current vs. Case Temperature

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

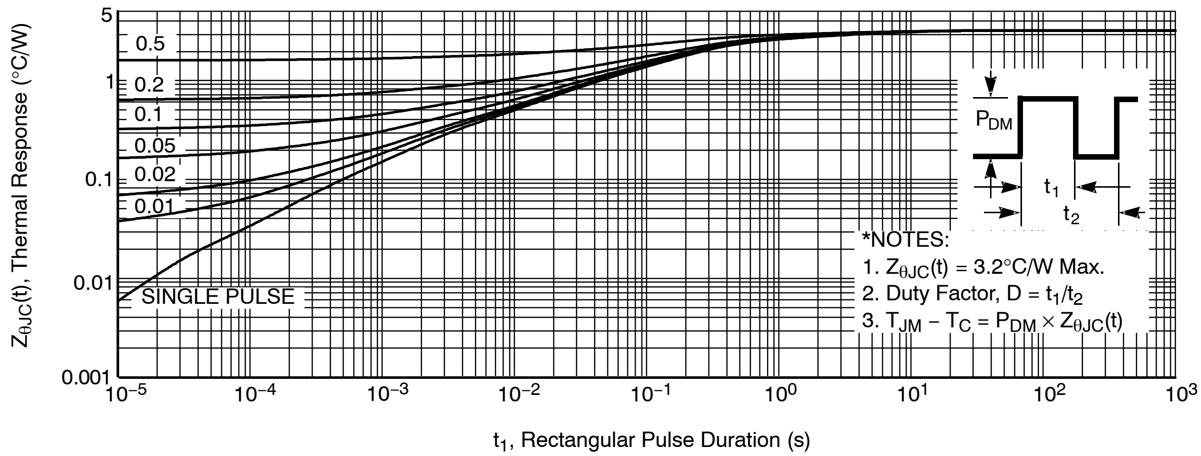


Figure 12. Transient Thermal Response Curve for FDPF12N60NZ

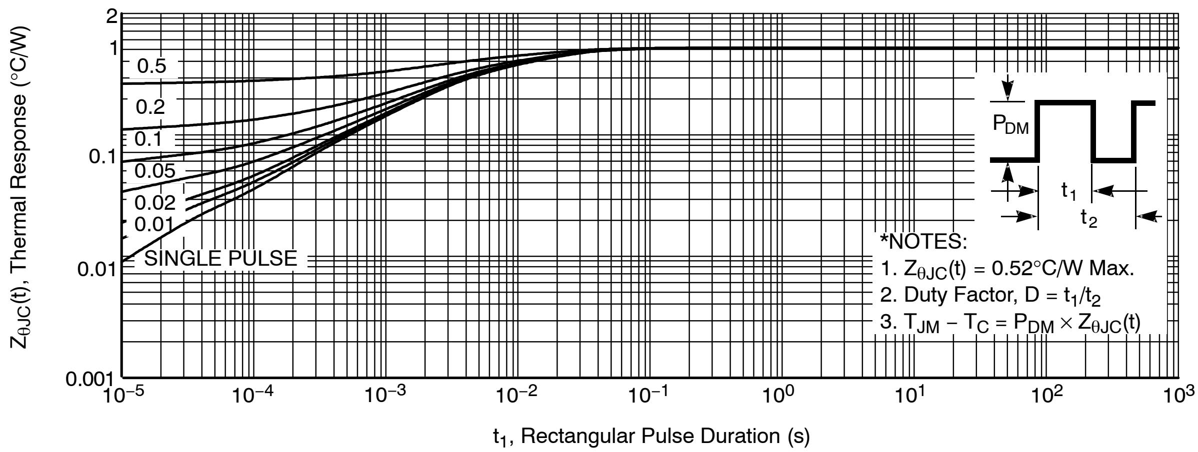


Figure 13. Transient Thermal Response Curve for FDP12N60NZ

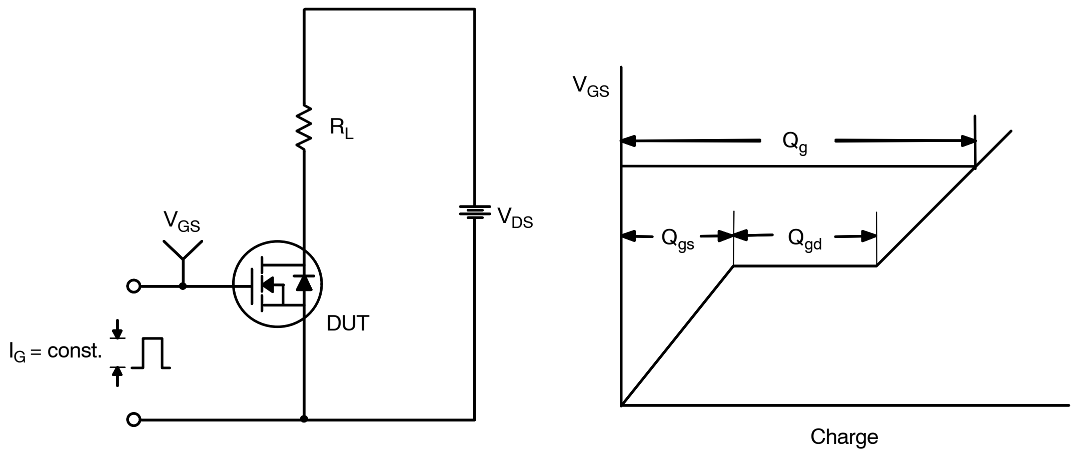


Figure 14. Gate Charge Test Circuit & Waveform

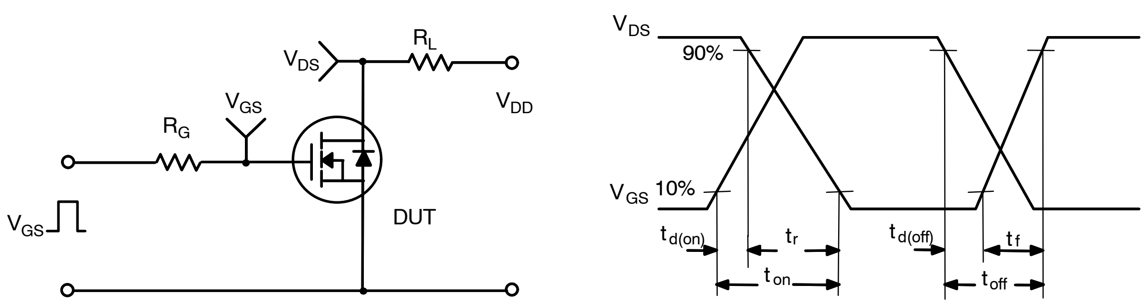


Figure 15. Resistive Switching Test Circuit & Waveforms

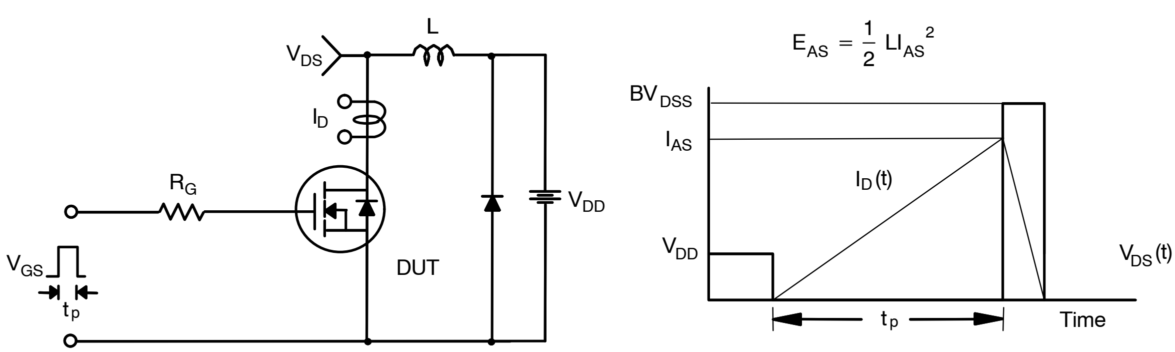


Figure 16. Unclamped Inductive Switching Test Circuit & Waveforms

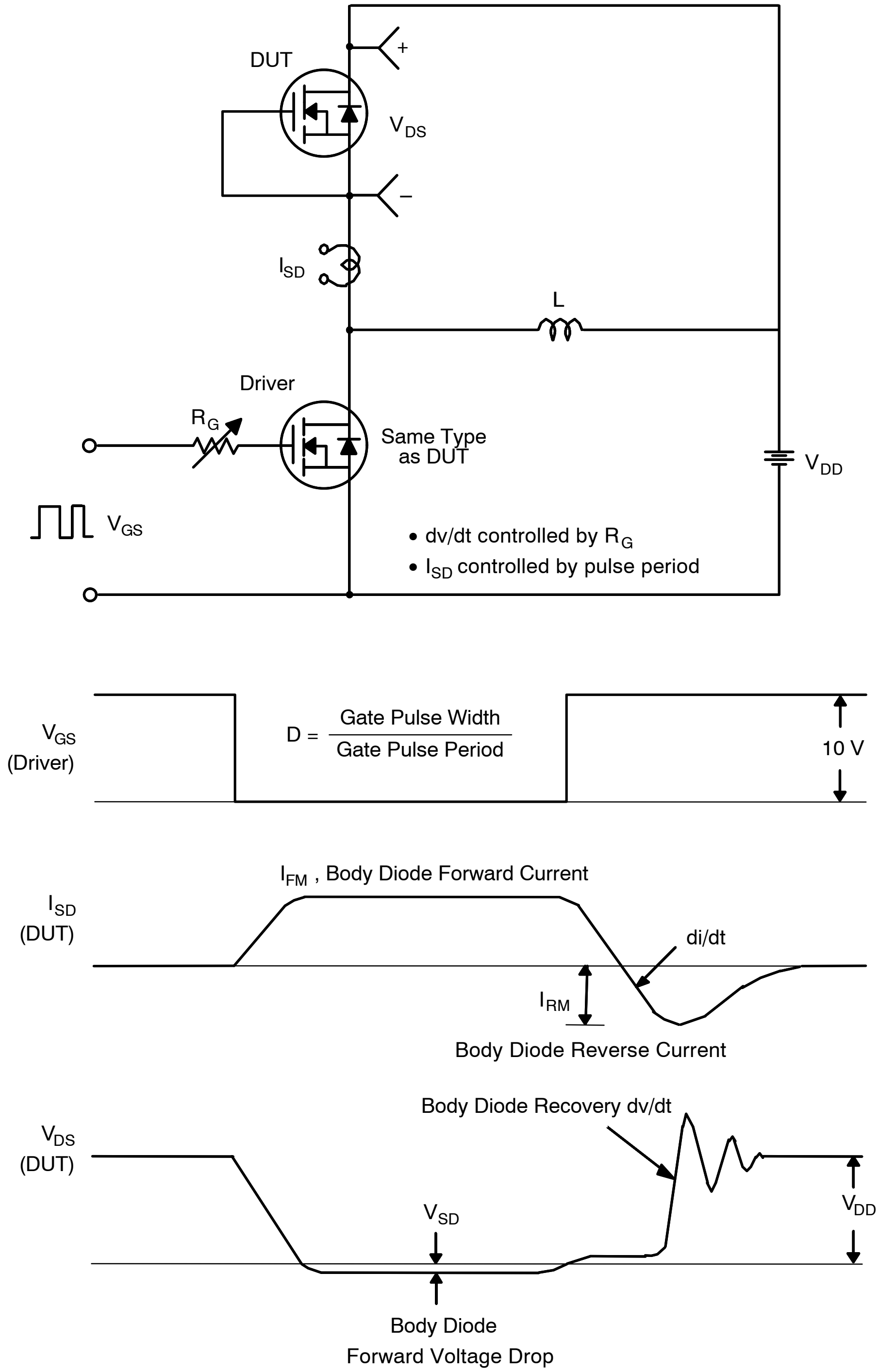
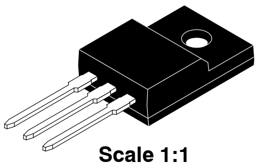


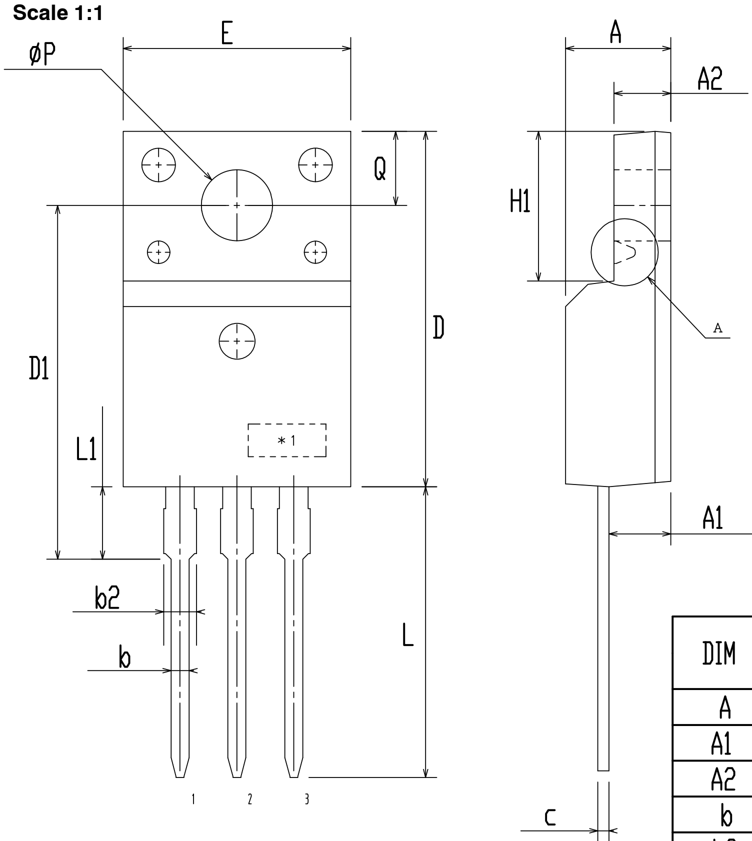
Figure 17. Peak Diode Recovery dv/dt Test Circuit & Waveforms

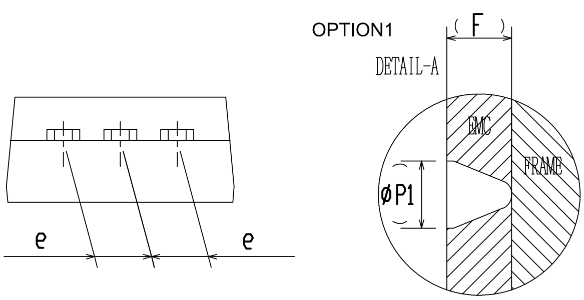


TO−220 Fullpack, 3−Lead / TO−220F−3SG
CASE 221AT
ISSUE B

DATE 19 JAN 2021

Scale 1:1





DIM	MILLIMITERS		
	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 PROTRUCSIONS.
C. OPTION 1 - WITH SUPPORT PIN HOLE
OPTION 2 - NO SUPPORT PIN HOLE

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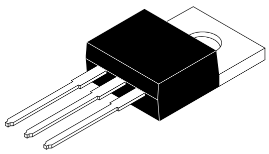
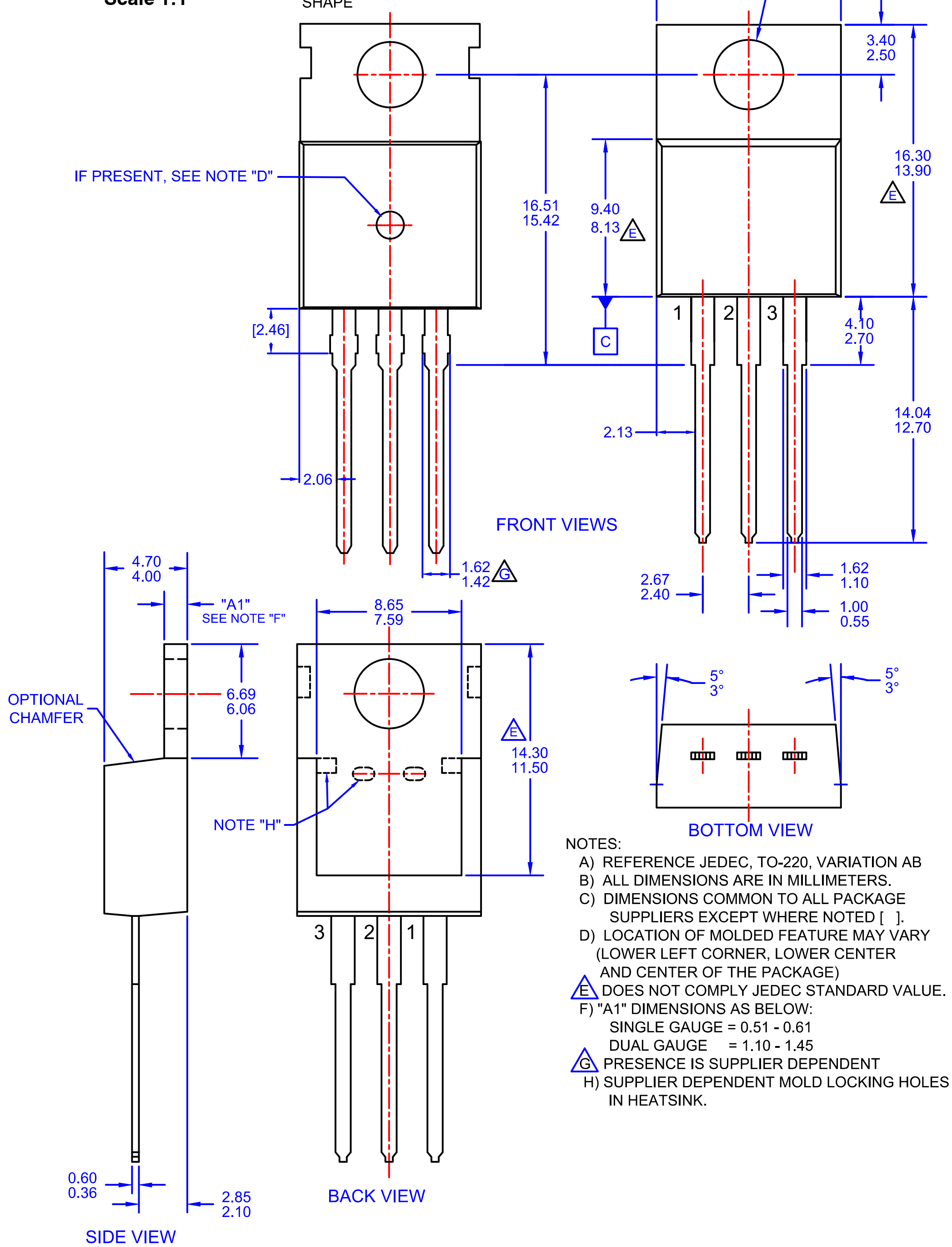
DESCRIPTION:	**TO−220 FULLPACK, 3−LEAD / TO−220F−3SG**	**PAGE 1 OF 1**



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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DESCRIPTION:	TO−220−3LD	PAGE 1 OF 1

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