

# MOSFET – N-Channel, UniFET™, FRFET®

**500 V, 20 A, 260 mΩ**

## FDP20N50F / FDPF20N50FT

### Description

UniFET MOSFET is onsemi's high voltage MOSFET family based on planar stripe and DMOS technology. This MOSFET is tailored to reduce on-state resistance, and to provide better switching performance and higher avalanche energy strength. The body diode's reverse recovery performance of UniFET FRFET MOSFET has been enhanced by lifetime control. Its  $t_{rr}$  is less than 100 ns and the reverse dv/dt immunity is 15 V/ns while normal planar MOSFET's have over 200 ns and 4.5 V/ns respectively. Therefore, it can remove additional component and improve system reliability in certain applications in which the performance of MOSFET's body diode is significant. 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.

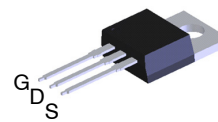
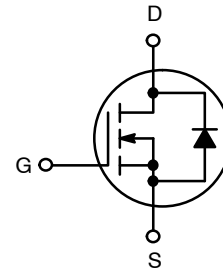
### Features

- $R_{DS(on)} = 210 \text{ m}\Omega$  (Typ.) @  $V_{GS} = 10 \text{ V}$ ,  $I_D = 10 \text{ A}$
- Low Gate Charge (Typ. 50 nC)
- Low  $C_{rss}$  (Typ. 27 pF)
- 100% Avalanche Tested
- Improve dv/dt Capability
- These Devices are Pb-Free and are RoHS Compliant

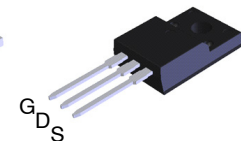
### Applications

- LCD/LED TV
- Lighting
- Uninterruptible Power Supply
- AC-DC Power Supply

$V_{DS}$	$R_{DS(on)}$ MAX	$I_D$ MAX
500 V	260 mΩ @ 10 V	20 A

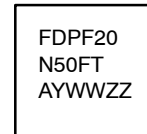
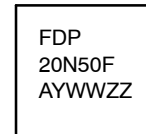


TO-220-3LD  
 CASE 340AT



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

### MARKING DIAGRAM



FDP20N50F,  
 FDPF20N50FT = Specific Device Code  
 A = Assembly Location  
 YWW = Date Code (Year & Week)  
 ZZ = Assembly Lot

### ORDERING INFORMATION

Device	Package	Shipping
FDP20N50F	TO-220	1000 Units / Tube
FDPF20N50FT	TO-220F	1000 Units / Tube

# FDP20N50F / FDPF20N50FT

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

Symbol	Parameter	FDP20N50F	FDPF20N50FT	Unit
$V_{DSS}$	Drain to Source Voltage	500		V
$V_{GSS}$	Gate to Source Voltage	$\pm 30$		V
$I_D$	Drain Current – – Continuous ( $T_C = 25^\circ\text{C}$ ) – Continuous ( $T_C = 100^\circ\text{C}$ )	20 12.9	20* 12.9*	A
$I_{DM}$	Drain Current – Pulsed (Note 1)	80	80*	A
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)	1110		mJ
$I_{AR}$	Avalanche Current (Note 1)	20		A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)	25		mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	20		V/ns
$P_D$	Power Dissipation ( $T_C = 25^\circ\text{C}$ ) – Derate Above $25^\circ\text{C}$	250 2.0	38.5 0.3	W 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 Second	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.  $L = 5\text{ mH}$ ,  $I_{AS} = 20\text{ A}$ ,  $V_{DD} = 50\text{ V}$ ,  $R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 20\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$

## THERMAL CHARACTERISTICS

Symbol	Parameter	FDP20N50F	FDPF20N50FT	Unit
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case, Max.	0.5	3.3	$^\circ\text{C}/\text{W}$
$R_{\theta CS}$	Thermal Resistance, Case-to-sink, Typ.	0.5	–	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient, Max.	62.5	62.5	$^\circ\text{C}/\text{W}$

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

$BV_{DSS}$	Drain-Source Breakdown Voltage	$I_D = 250\ \mu\text{A}$ , $V_{GS} = 0\text{ V}$ , $T_J = 25^\circ\text{C}$	500	–	–	V
$\Delta BV_{DSS} / \Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$	–	0.7	–	V/ $^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 500\text{ V}$ , $V_{GS} = 0\text{ V}$	–	–	10	$\mu\text{A}$
		$V_{DS} = 400\text{ V}$ , $T_C = 125^\circ\text{C}$	–	–	100	
$I_{GSS}$	Gate-Body Leakage Current	$V_{GS} = \pm 30\text{ V}$ , $V_{DS} = 0\text{ V}$	–	–	$\pm 100$	nA

### ON CHARACTERISTICS

$V_{GS(th)}$	Gate Threshold Voltage	$V_{GS} = V_{DS}$ , $I_D = 250\ \mu\text{A}$	3.0	–	5.0	V
$R_{DS(on)}$	Static Drain-Source On Resistance	$V_{GS} = 10\text{ V}$ , $I_D = 10\text{ A}$	–	0.22	0.26	$\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS} = 20\text{ V}$ , $I_D = 10\text{ A}$	–	25	–	S

### DYNAMIC CHARACTERISTICS

$C_{iss}$	Input Capacitance	$V_{DS} = 25\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$	–	2550	3390	pF
$C_{oss}$	Output Capacitance		–	350	465	pF
$C_{rss}$	Reverse Transfer Capacitance		–	27	40	pF
$Q_{g(tot)}$	Total Gate Charge at 10 V	$V_{DS} = 400\text{ V}$ , $I_D = 20\text{ A}$ , $V_{GS} = 10\text{ V}$ (Note 4)	–	50	65	nC
$Q_{gs}$	Gate to Source Gate Charge		–	14	–	nC
$Q_{gd}$	Gate to Drain "Miller" Charge		–	20	–	nC

## FDP20N50F / FDPF20N50FT

### ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted) (continued)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
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#### SWITCHING CHARACTERISTICS

$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 250\text{ V}$ , $I_D = 20\text{ A}$ , $R_G = 25\ \Omega$ (Note 4)	–	45	100	ns
$t_r$	Turn-On Rise Time		–	120	250	ns
$t_{d(off)}$	Turn-Off Delay Time		–	100	210	ns
$t_f$	Turn-Off Fall Time		–	60	130	ns

#### DRAIN-SOURCE DIODE CHARACTERISTICS

$I_S$	Maximum Continuous Drain to Source Diode Forward Current		–	–	20	A
$I_{SM}$	Maximum Pulsed Drain to Source Diode Forward Current		–	–	80	A
$V_{SD}$	Drain to Source Diode Forward Voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 20\text{ A}$	–	–	1.5	V
$t_{rr}$	Reverse Recovery Time	$V_{GS} = 0\text{ V}$ , $I_{SD} = 20\text{ A}$ $di_F/dt = 100\text{ A}/\mu\text{s}$	–	154	–	ns
$Q_{rr}$	Reverse Recovery Charge		–	0.5	–	$\mu\text{C}$

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

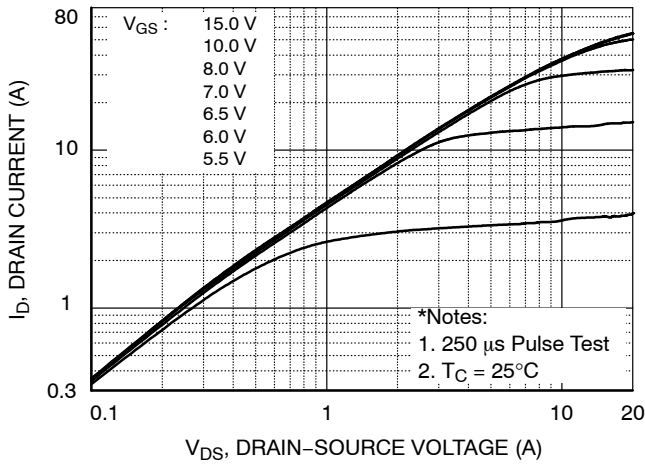


Figure 1. On-Region Characteristics

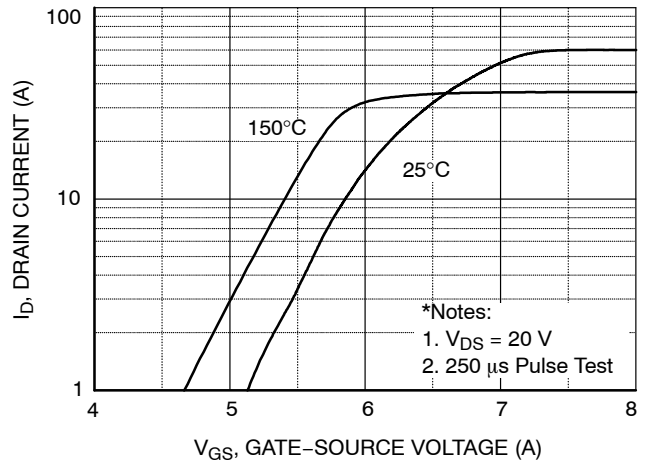


Figure 2. Transfer Characteristics

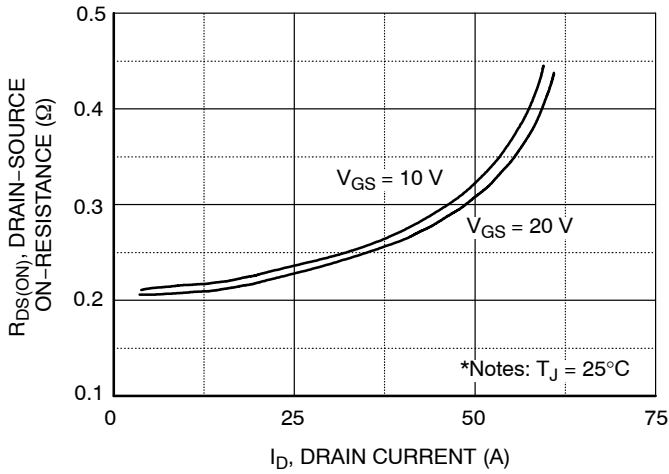


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

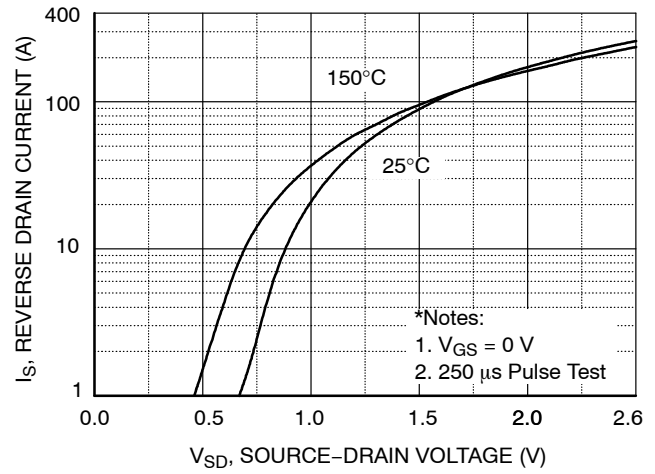


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

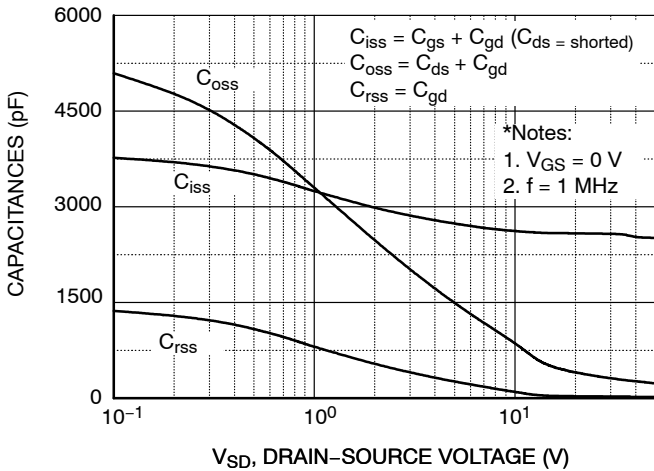


Figure 5. Capacitance Characteristics

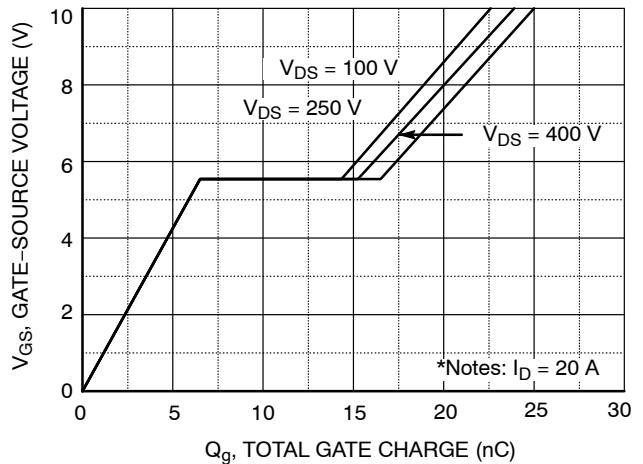
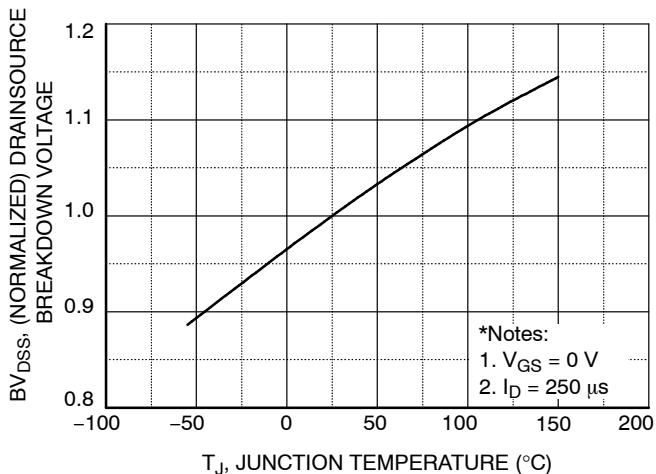


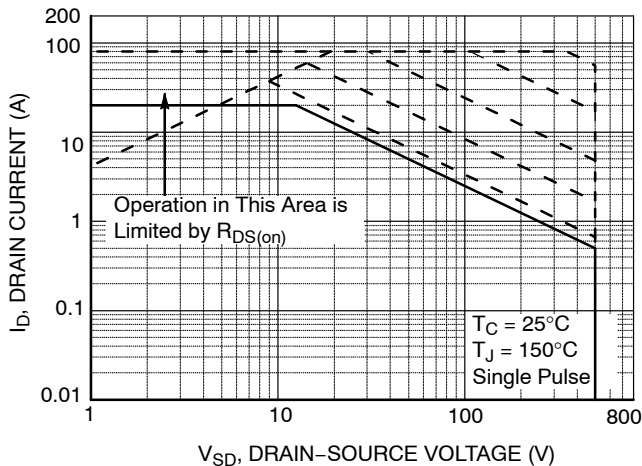
Figure 6. Gate Charge Characteristics

# FDP20N50F / FDPF20N50FT

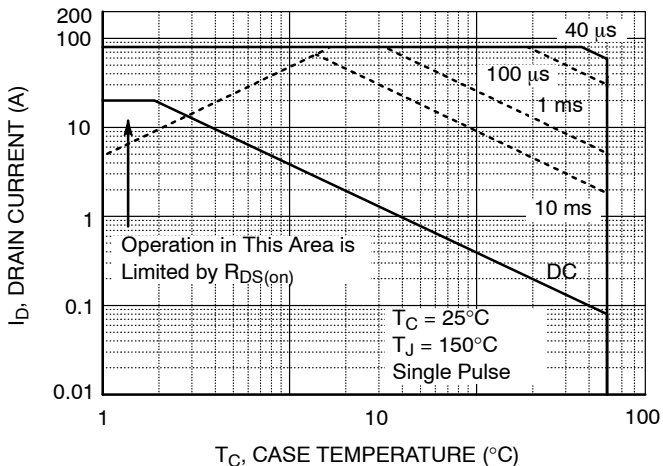
## TYPICAL CHARACTERISTICS (continued)



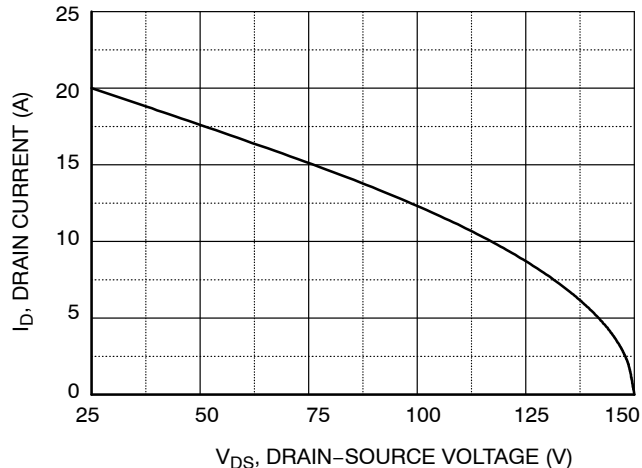
**Figure 7. Breakdown Voltage Variation vs. Temperature**



**Figure 8. Maximum Safe Operating Area - FDP20N50F**



**Figure 9. Maximum Safe Operating Area - FDP20N50F**



**Figure 10. Maximum Drain Current vs. Case Temperature**

# FDP20N50F / FDPF20N50FT

## Typical Performance Characteristics (continued)

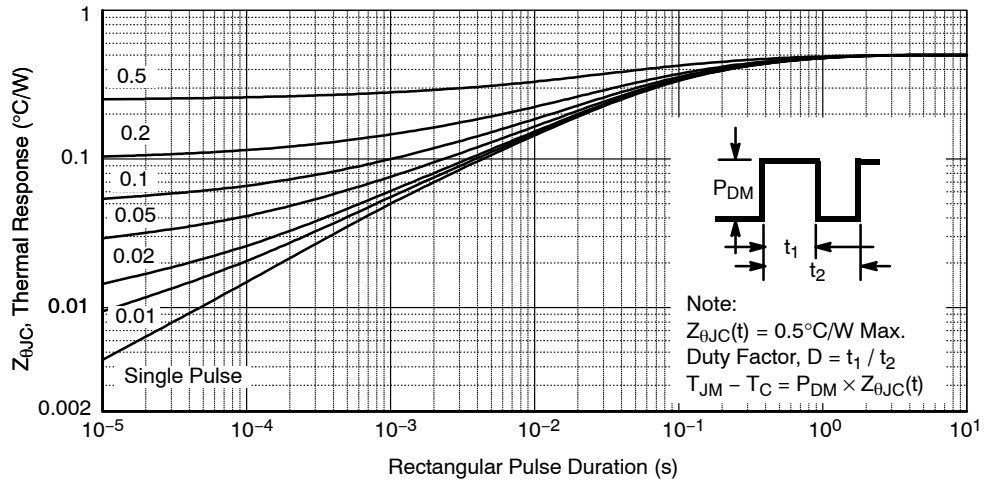


Figure 11. Transient Thermal Response Curve for FDP20N50F

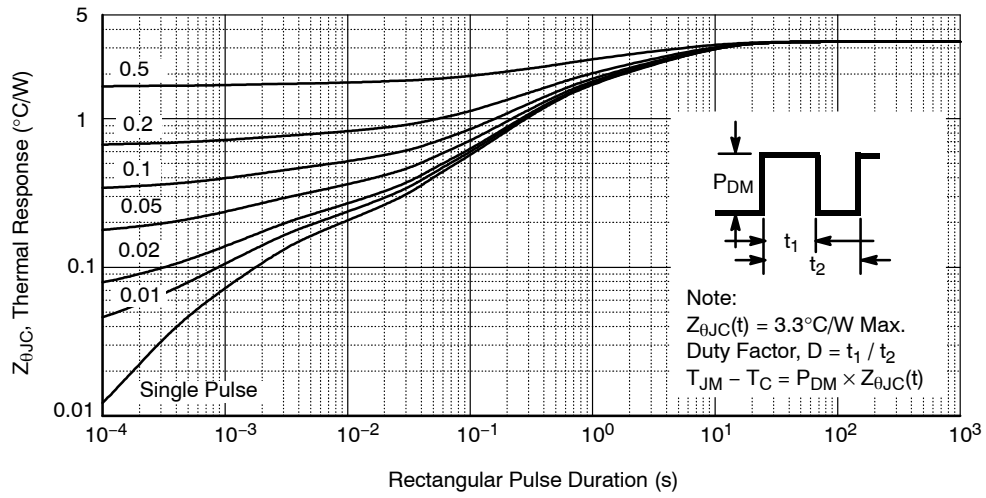


Figure 12. Transient Thermal Response Curve for FDPF20N50FT

# FDP20N50F / FDPF20N50FT

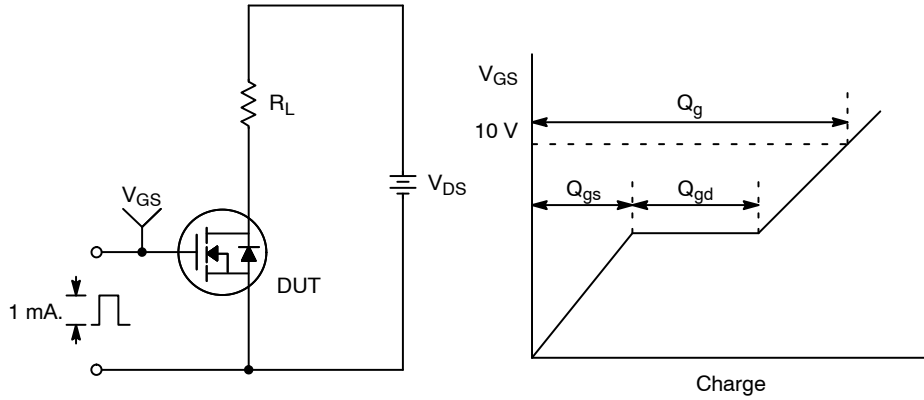


Figure 13. Gate Charge Test Circuit & Waveform

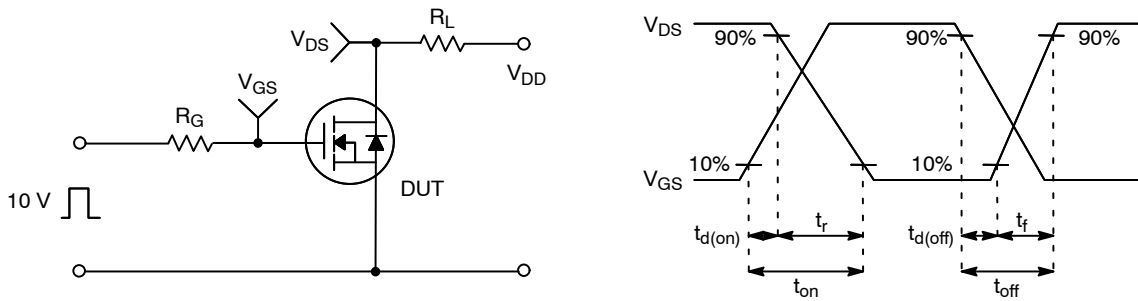


Figure 14. Resistive Switching Test Circuit & Waveforms

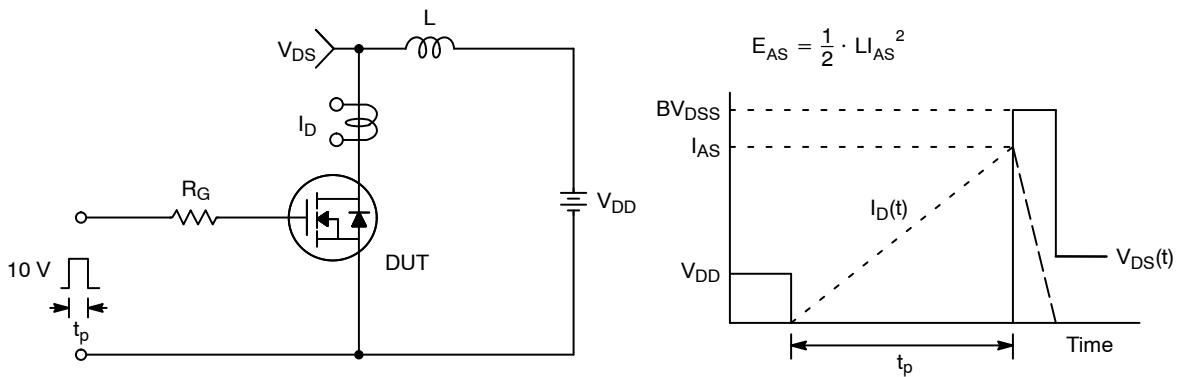
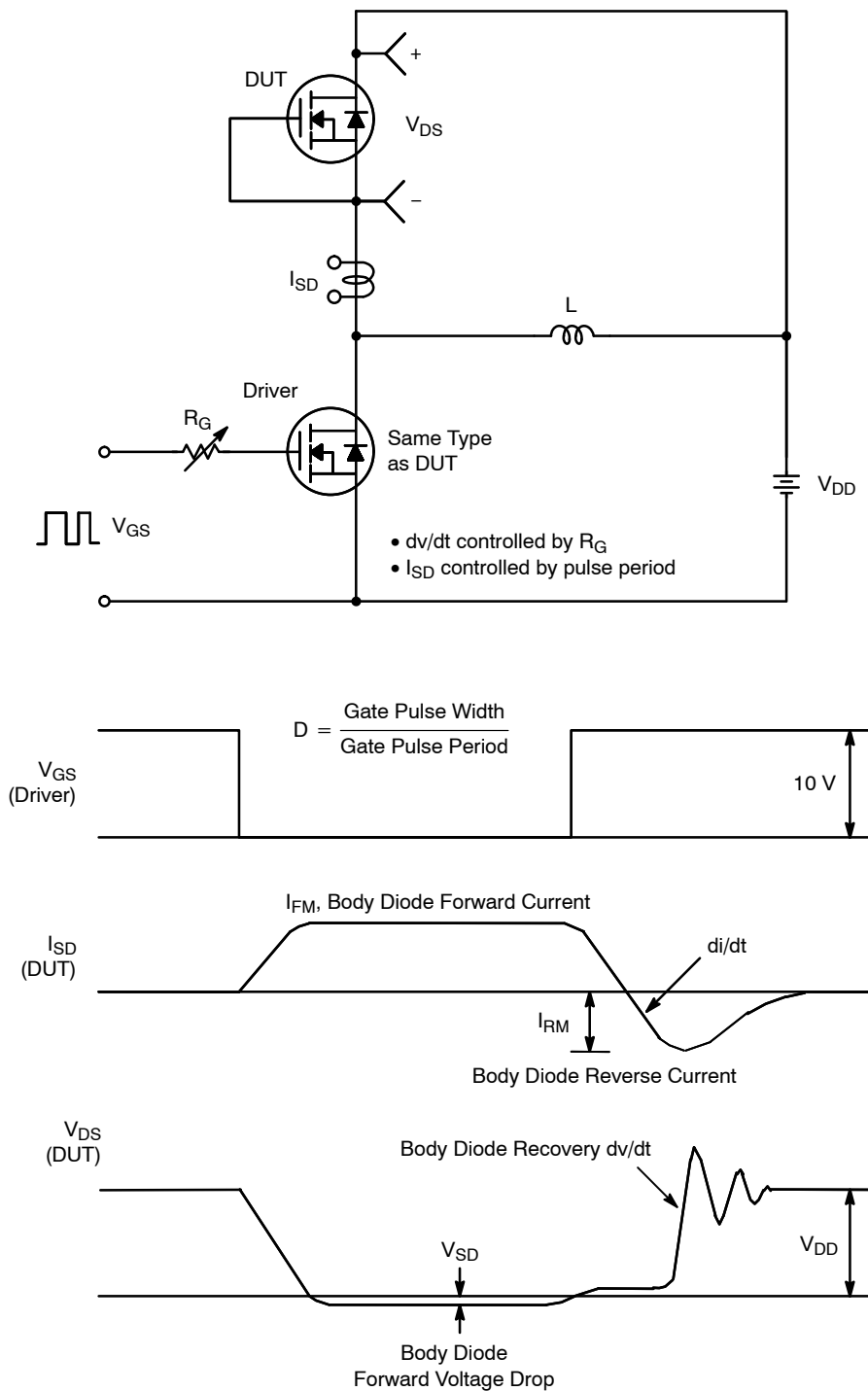


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

# FDP20N50F / FDPF20N50FT



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

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# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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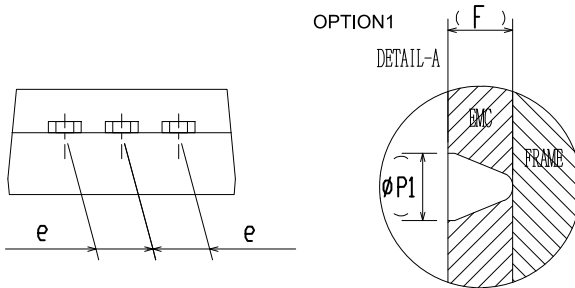


### TO-220 Fullpack, 3-Lead / TO-220F-3SG CASE 221AT ISSUE B

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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<b>DESCRIPTION:</b>	<b>TO-220 FULLPACK, 3-LEAD / TO-220F-3SG</b>	<b>PAGE 1 OF 1</b>

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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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