

# MOSFET – N-Channel, UniFET™

500 V, 20 A, 230 mΩ

## FDP20N50/FDPF20N50 /FDPF20N50T

### 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. 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

- $R_{DS(on)} = 200 \text{ m}\Omega$  (Typ.) @  $V_{GS} = 10 \text{ V}$ ,  $I_D = 10 \text{ A}$
- Low Gate Charge (Typ. 45.6 nC)
- Low  $C_{rss}$  (Typ. 27 pF)
- 100% Avalanche Tested

### Applications

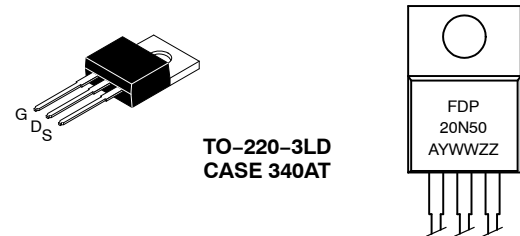
- LCD/LED/PDP TV
- Lighting
- Uninterruptible Power Supply
- AC-DC Power Supply

| $V_{DSS}$ | $R_{DS(on)}$ MAX | $I_D$ MAX |
|-----------|------------------|-----------|
| 500 V     | 230 mΩ @ 10 V    | 20 A      |

### MARKING DIAGRAMS

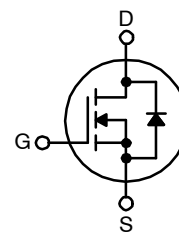


FDPF20N50(T) = Specific Device Code  
A = Assembly Location  
YWW = Date Code (Year & Week)  
ZZ = Assembly Lot



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A = Assembly Location  
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ZZ = Assembly Lot

### N-CHANNEL MOSFET



### ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

# FDP20N50/FDPF20N50

## ABSOLUTE MAXIMUM RATINGS (T<sub>C</sub> = 25°C unless otherwise noted)

| Symbol                            | Parameter                                                               |                                     | FDP20N50    | FDPF20N50/<br>FDPF20N50T | Unit |
|-----------------------------------|-------------------------------------------------------------------------|-------------------------------------|-------------|--------------------------|------|
| V <sub>DSS</sub>                  | Drain–Source Voltage                                                    |                                     | 500         |                          | V    |
| I <sub>D</sub>                    | Drain Current                                                           | Continuous (T <sub>C</sub> = 25°C)  | 20          | 20*                      | A    |
|                                   |                                                                         | Continuous (T <sub>C</sub> = 100°C) | 12.9        | 12.9*                    |      |
| I <sub>DM</sub>                   | Drain Current                                                           | Pulsed (Note 1)                     | 80          | 80*                      | A    |
| V <sub>GSS</sub>                  | Gate–Source Voltage                                                     |                                     | ±30         |                          | V    |
| E <sub>AS</sub>                   | Single Pulsed Avalanche Energy (Note 2)                                 |                                     | 1110        |                          | mJ   |
| I <sub>AR</sub>                   | Avalanche Current (Note 1)                                              |                                     | 20          |                          | A    |
| E <sub>AR</sub>                   | Repetitive Avalanche Energy (Note 1)                                    |                                     | 25          |                          | mJ   |
| dv/dt                             | Peak Diode Recovery dv/dt (Note 3)                                      |                                     | 4.5         |                          | V/ns |
| P <sub>D</sub>                    | Power Dissipation                                                       | (T <sub>C</sub> = 25°C)             | 250         | 38.5                     | W    |
|                                   |                                                                         | Derate above 25°C                   | 2.0         | 0.3                      | W/°C |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage Temperature Range                                 |                                     | –55 to +150 |                          | °C   |
| T <sub>L</sub>                    | Maximum Lead Temperature for Soldering,<br>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 = 5.0 mH, I<sub>AS</sub> = 20 A, V<sub>DD</sub> = 50 V, R<sub>G</sub> = 25 Ω, starting T<sub>J</sub> = 25°C.

3. I<sub>SD</sub> ≤ 20 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> ≤ BV<sub>DSS</sub>, starting T<sub>J</sub> = 25°C.

## THERMAL CHARACTERISTICS

| Symbol           | Parameter                                     | FDP20N50 | FDPF20N50/<br>FDPF20N50T | Unit |
|------------------|-----------------------------------------------|----------|--------------------------|------|
| R <sub>θJC</sub> | Thermal Resistance, Junction–to–Case, Max.    | 0.5      | 3.3                      | °C/W |
| R <sub>θJA</sub> | Thermal Resistance, Junction–to–Ambient, Max. | 62.5     | 62.5                     |      |

# FDP20N50/FDPF20N50

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------|-----------|------------|-----|-----|-----|------|
|--------|-----------|------------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                      |                                           |                                                                                                   |     |     |         |          |
|--------------------------------------|-------------------------------------------|---------------------------------------------------------------------------------------------------|-----|-----|---------|----------|
| BV <sub>DSS</sub>                    | Drain-Source Breakdown Voltage            | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                    | 500 | –   | –       | V        |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 250 μA, Referenced to 25°C                                                       | –   | 0.5 | –       | V/°C     |
| I <sub>DSS</sub>                     | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = 500 V, V <sub>GS</sub> = 0 V<br>V <sub>DS</sub> = 400 V, T <sub>C</sub> = 125°C | –   | –   | 1<br>10 | μA<br>μA |
| I <sub>GSSF</sub>                    | Gate-Body Leakage Current, Forward        | V <sub>GS</sub> = 30 V, V <sub>DS</sub> = 0 V                                                     | –   | –   | 100     | nA       |
| I <sub>GSSR</sub>                    | Gate-Body Leakage Current, Reverse        | V <sub>GS</sub> = –30 V, V <sub>DS</sub> = 0V                                                     | –   | –   | –100    | nA       |

### ON CHARACTERISTICS

|                     |                                   |                                                             |     |      |      |   |
|---------------------|-----------------------------------|-------------------------------------------------------------|-----|------|------|---|
| V <sub>GS(th)</sub> | Gate Threshold Voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA | 3.0 | –    | 5.0  | V |
| R <sub>DS(on)</sub> | Static Drain-Source On-Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 10 A               | –   | 0.20 | 0.23 | Ω |
| g <sub>FS</sub>     | Forward Transconductance          | V <sub>DS</sub> = 40 V, I <sub>D</sub> = 10 A               | –   | 24.6 | –    | S |

### DYNAMIC CHARACTERISTICS

|                  |                              |                                                            |   |      |      |    |
|------------------|------------------------------|------------------------------------------------------------|---|------|------|----|
| C <sub>iss</sub> | Input Capacitance            | V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V, f = 1.0 MHz | – | 2400 | 3120 | pF |
| C <sub>oss</sub> | Output Capacitance           |                                                            | – | 355  | 465  | pF |
| C <sub>rss</sub> | Reverse Transfer Capacitance |                                                            | – | 27   | –    | pF |

### SWITCHING CHARACTERISTICS

|                     |                     |                                                                                                           |   |      |      |    |
|---------------------|---------------------|-----------------------------------------------------------------------------------------------------------|---|------|------|----|
| t <sub>d(on)</sub>  | Turn-On Delay Time  | V <sub>DD</sub> = 250 V, I <sub>D</sub> = 20 A, V <sub>GS</sub> = 10 V,<br>R <sub>G</sub> = 25 Ω (Note 4) | – | 95   | 200  | ns |
| t <sub>r</sub>      | Turn-On Rise Time   |                                                                                                           | – | 375  | 760  | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time |                                                                                                           | – | 100  | 210  | ns |
| t <sub>f</sub>      | Turn-Off Fall Time  |                                                                                                           | – | 105  | 220  | ns |
| Q <sub>g</sub>      | Total Gate Charge   | V <sub>DS</sub> = 400 V, I <sub>D</sub> = 20 A, V <sub>GS</sub> = 10 V<br>(Note 4)                        | – | 45.6 | 59.5 | nC |
| Q <sub>gs</sub>     | Gate-Source Charge  |                                                                                                           | – | 14.8 | –    | nC |
| Q <sub>gd</sub>     | Gate-Drain Charge   |                                                                                                           | – | 21.6 | –    | nC |

### DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

|                 |                                                       |                                                                                 |   |      |     |    |
|-----------------|-------------------------------------------------------|---------------------------------------------------------------------------------|---|------|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain–Source Diode Forward Current |                                                                                 | – | –    | 30  | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain–Source Diode Forward Current     |                                                                                 | – | –    | 80  | A  |
| V <sub>SD</sub> | Drain–Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 20 A                                    | – | –    | 1.4 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 20 A,<br>dI <sub>F</sub> /dt = 100 A/μs | – | 507  | –   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                               |                                                                                 | – | 7.20 | –   | 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.

# FDP20N50/FDPF20N50

## TYPICAL CHARACTERISTICS

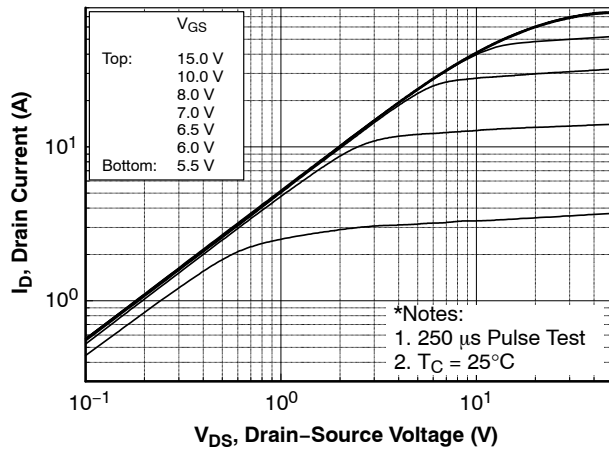


Figure 1. On-Region Characteristics

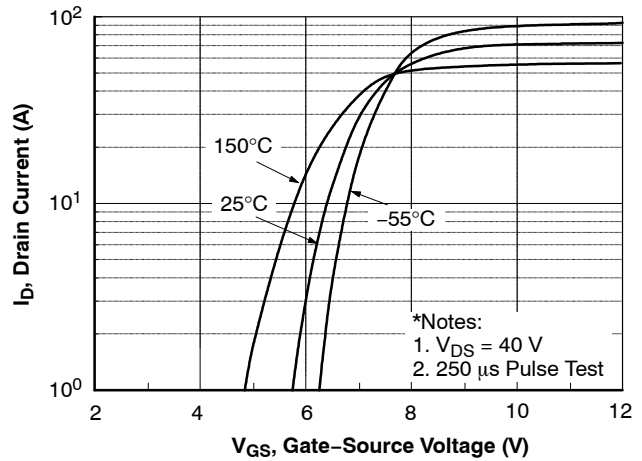


Figure 2. Transfer Characteristics

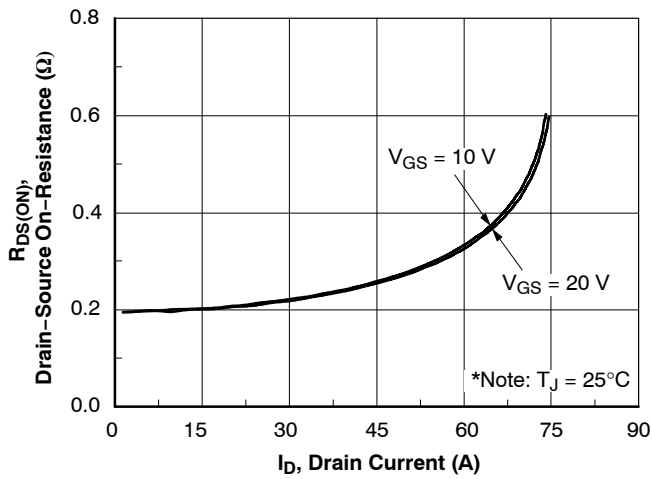


Figure 3. On-Resistance Variation vs. Drain Current and Gate voltage

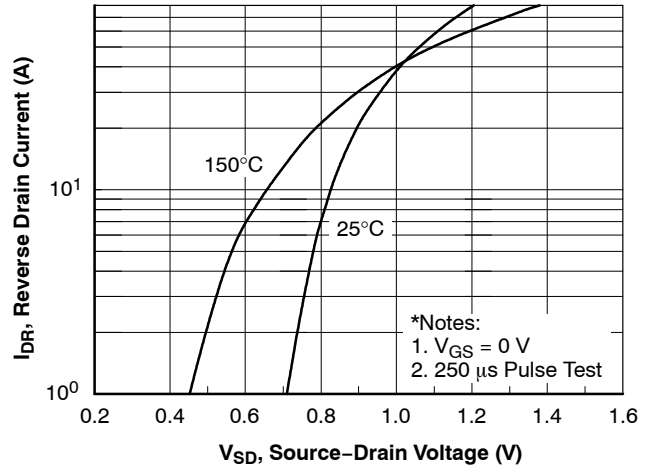


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

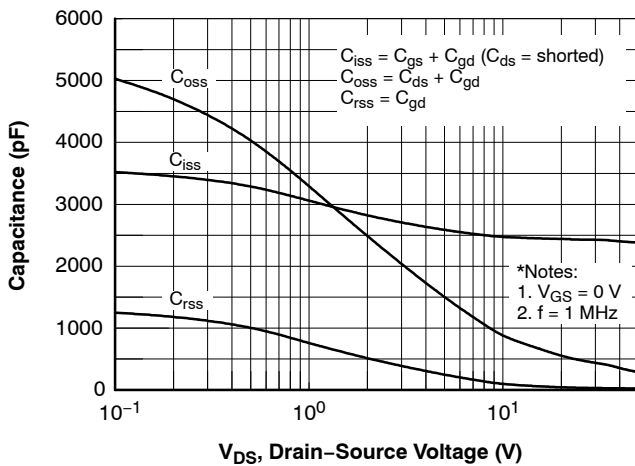


Figure 5. Capacitance Characteristics

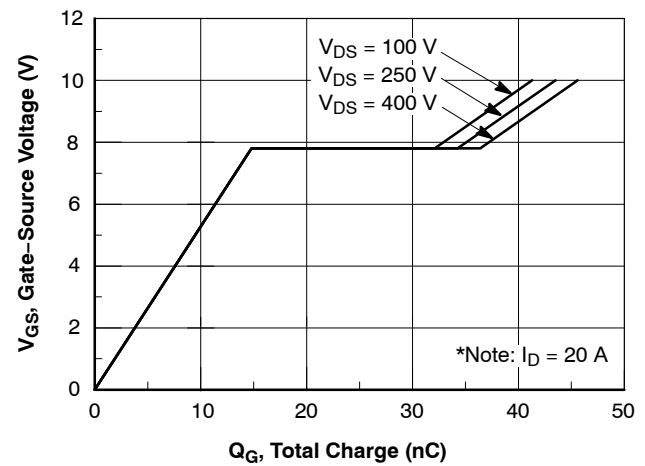


Figure 6. Gate Charge Characteristics

TYPICAL CHARACTERISTICS (CONTINUED)

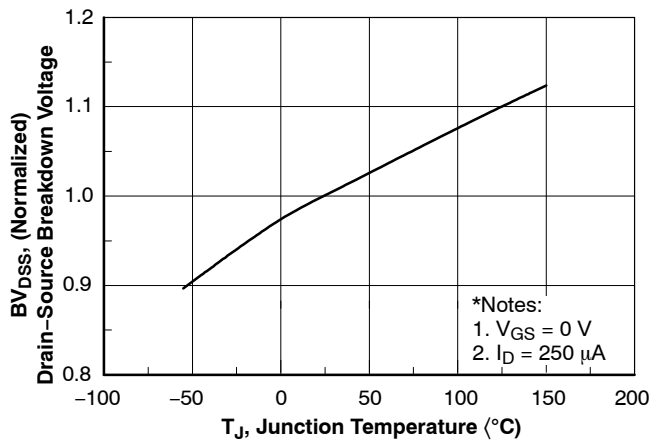


Figure 7. Breakdown Voltage Variation vs. Temperature

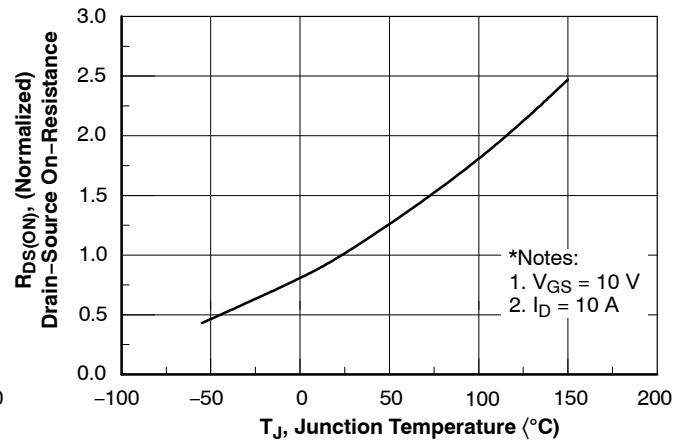


Figure 8. On-Resistance Variation vs. Temperature

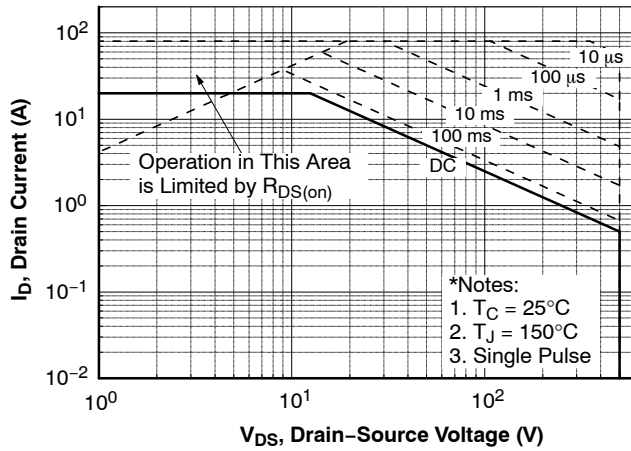


Figure 9. Maximum Safe Operating Area - FDP20N50

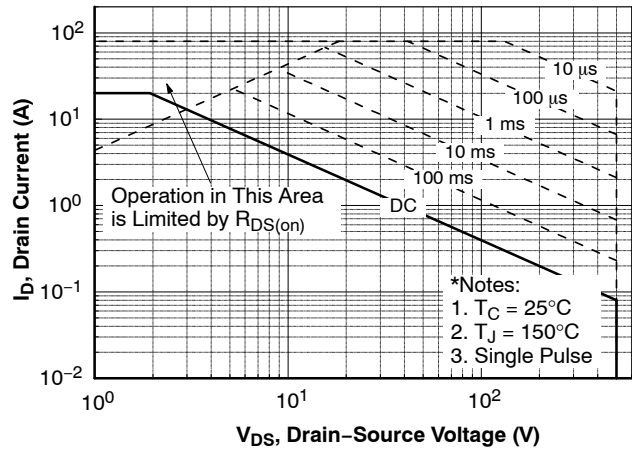


Figure 10. Maximum Safe Operating Area - FDPF20N50

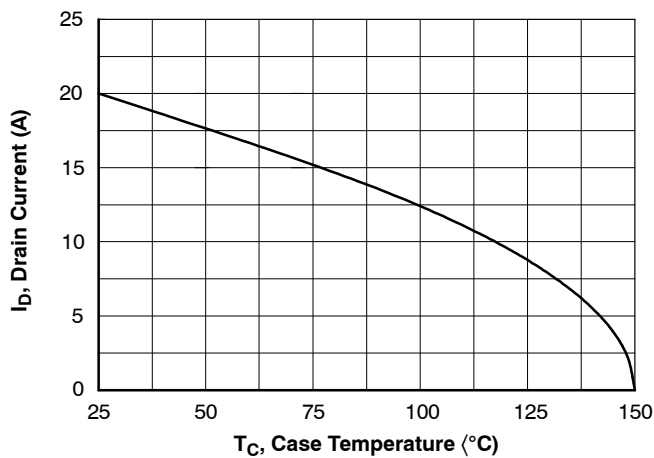


Figure 11. Maximum Drain Current vs. Case Temperature

# FDP20N50/FDPF20N50

## TYPICAL CHARACTERISTICS (CONTINUED)

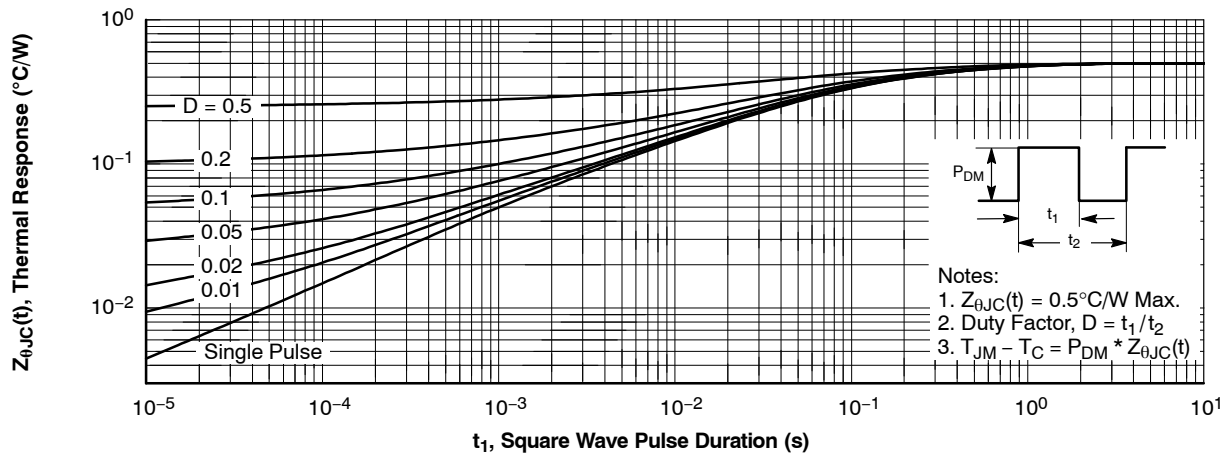


Figure 13. Transient Thermal Response Curve – FDP20N50

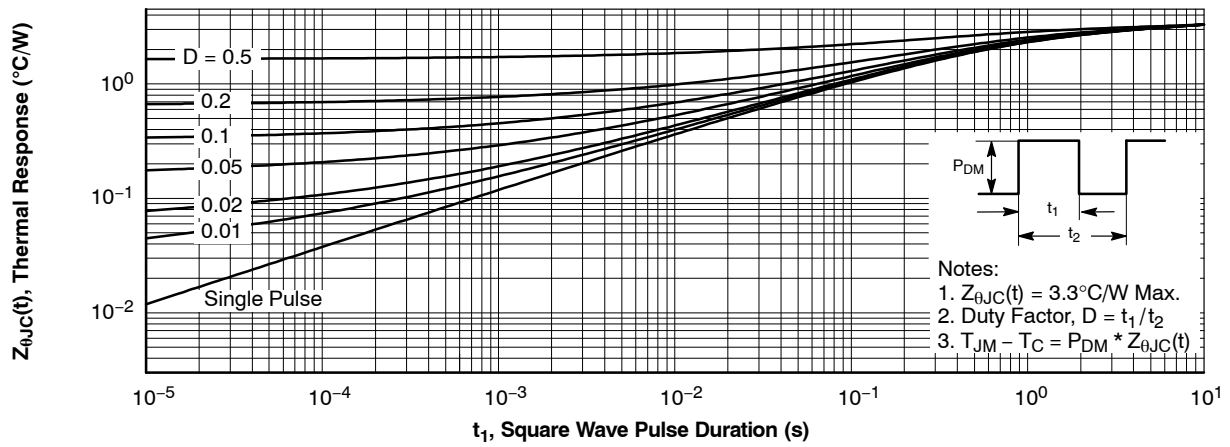


Figure 12. Transient Thermal Response Curve – FDPF20N50

## FDP20N50/FDPF20N50

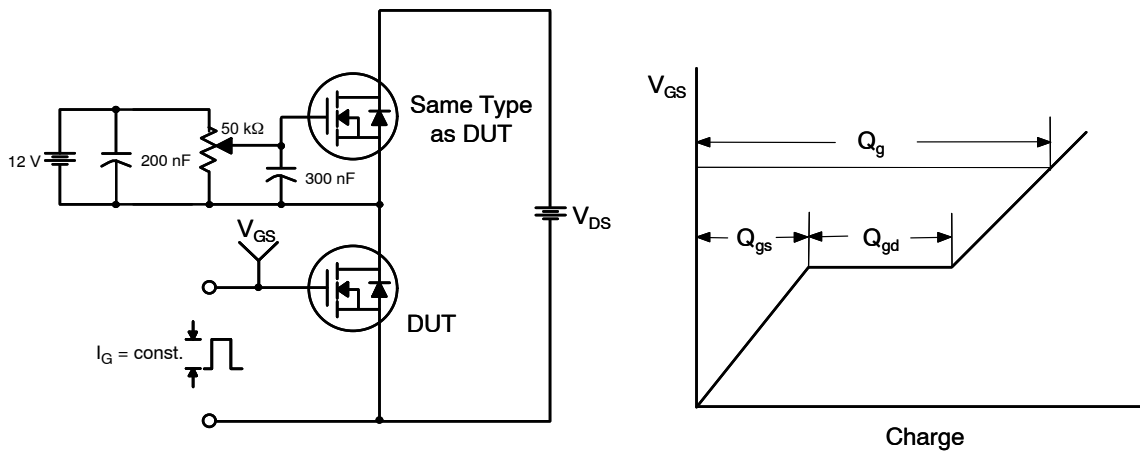


Figure 14. Gate Charge Test Circuit & Waveform

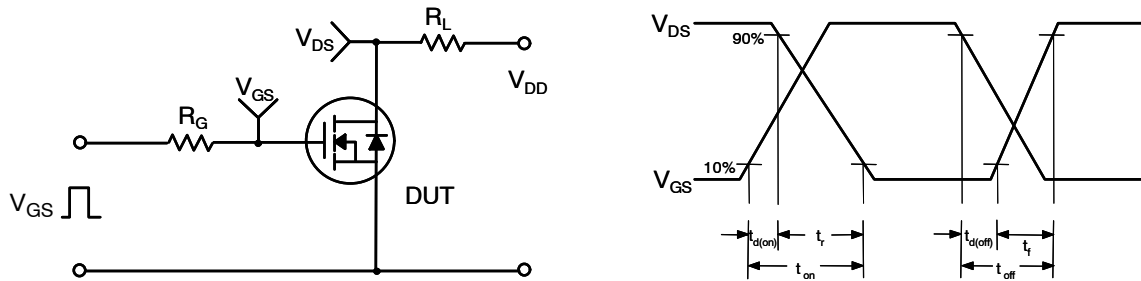


Figure 15. Resistive Switching Test Circuit & Waveforms

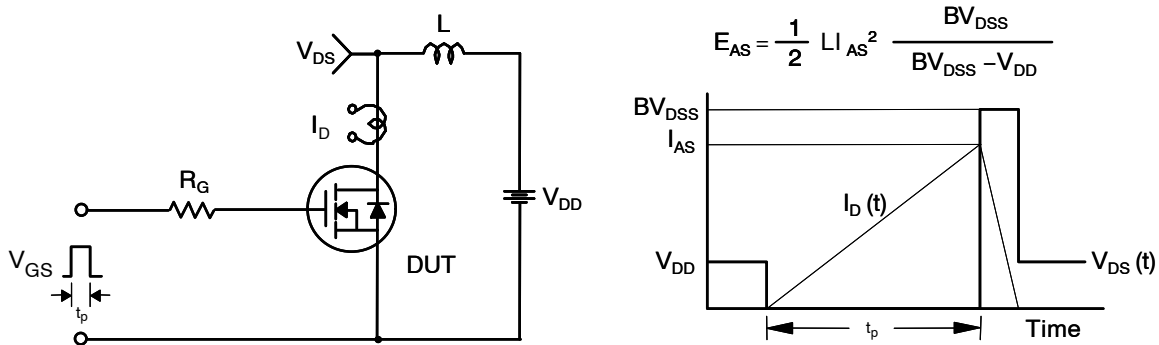


Figure 16. Unclamped Inductive Switching Test Circuit & Waveforms

# FDP20N50/FDPF20N50

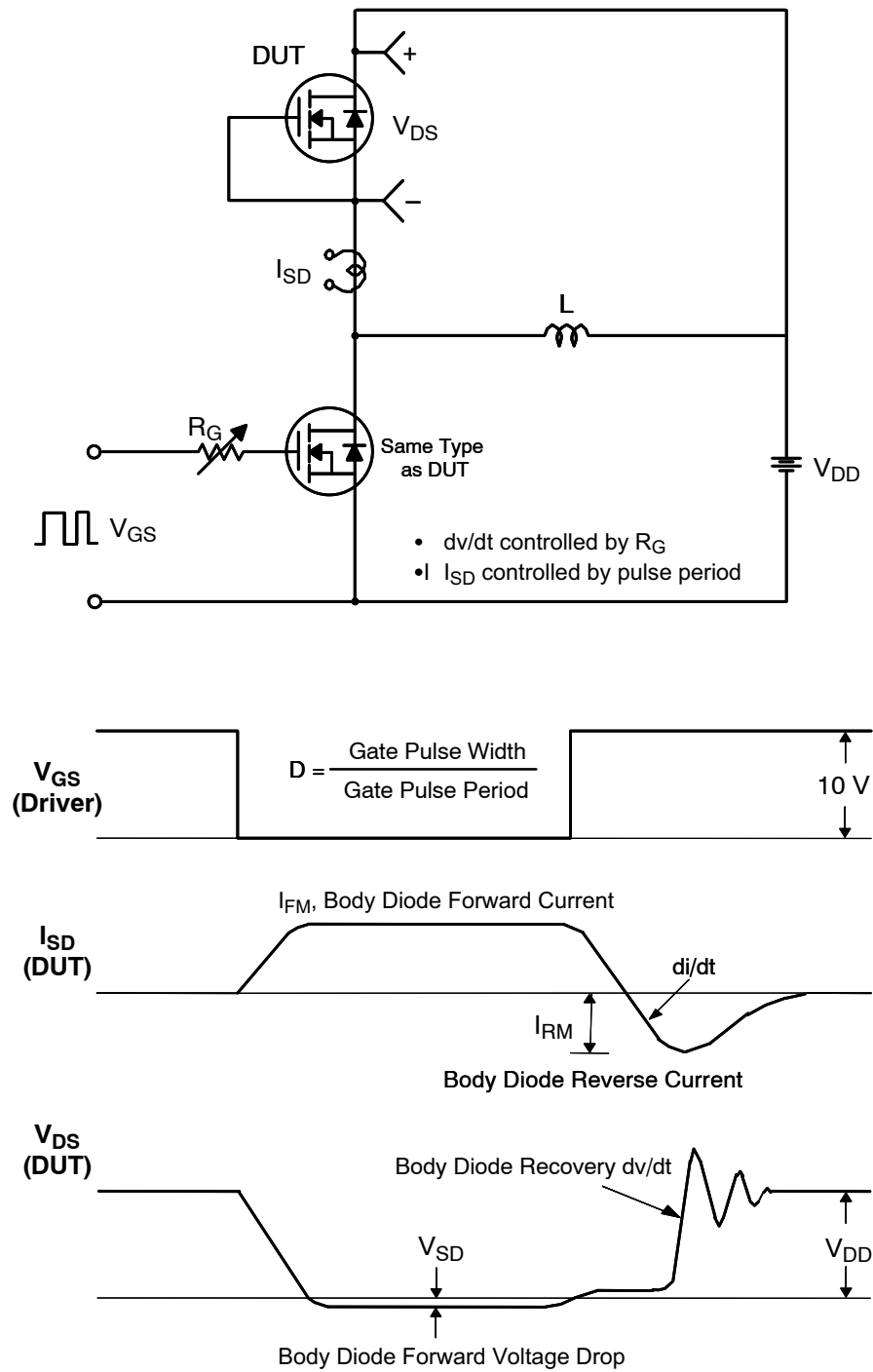


Figure 17. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms

## FDP20N50/FDPF20N50

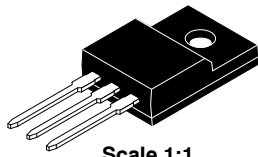
### PACKAGE MARKING AND ORDERING INFORMATION

| Part Number | Top Mark  | Package                                                | Quantity          |
|-------------|-----------|--------------------------------------------------------|-------------------|
| FDP20N50    | FDP20N50  | TO-220-3LD<br>CASE 340AT                               | 1000 Units / Tube |
| FDPF20N50   | FDPF20N50 | TO-220 Fullpack, 3-Lead /<br>TO-220F-3SG<br>CASE 221AT | 1000 Units / Tube |
| FDPF20N50T  | FDPF20N50 | TO-220 Fullpack, 3-Lead /<br>TO-220F-3SG<br>CASE 221AT | 1000 Units / Tube |

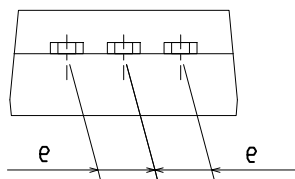
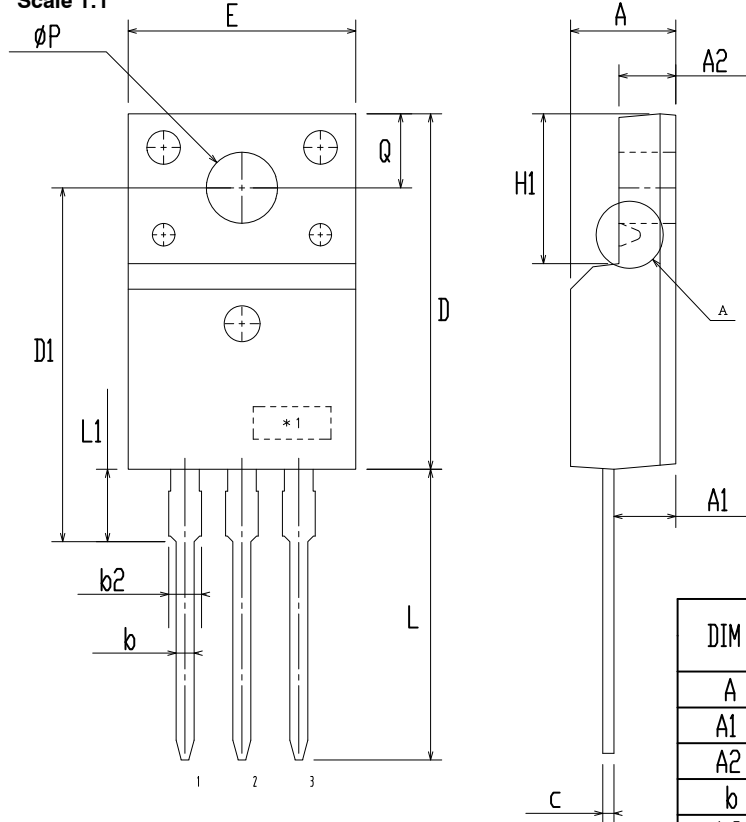
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**TO-220 Fullpack, 3-Lead / TO-220F-3SG**  
**CASE 221AT**  
**ISSUE B**

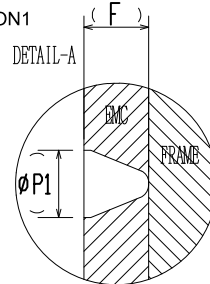
DATE 19 JAN 2021



Scale 1:1



OPTION1



| 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

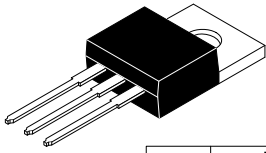
B. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUCTIONS.

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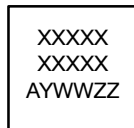
### TO-220-3LD CASE 340AT ISSUE B

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°    |

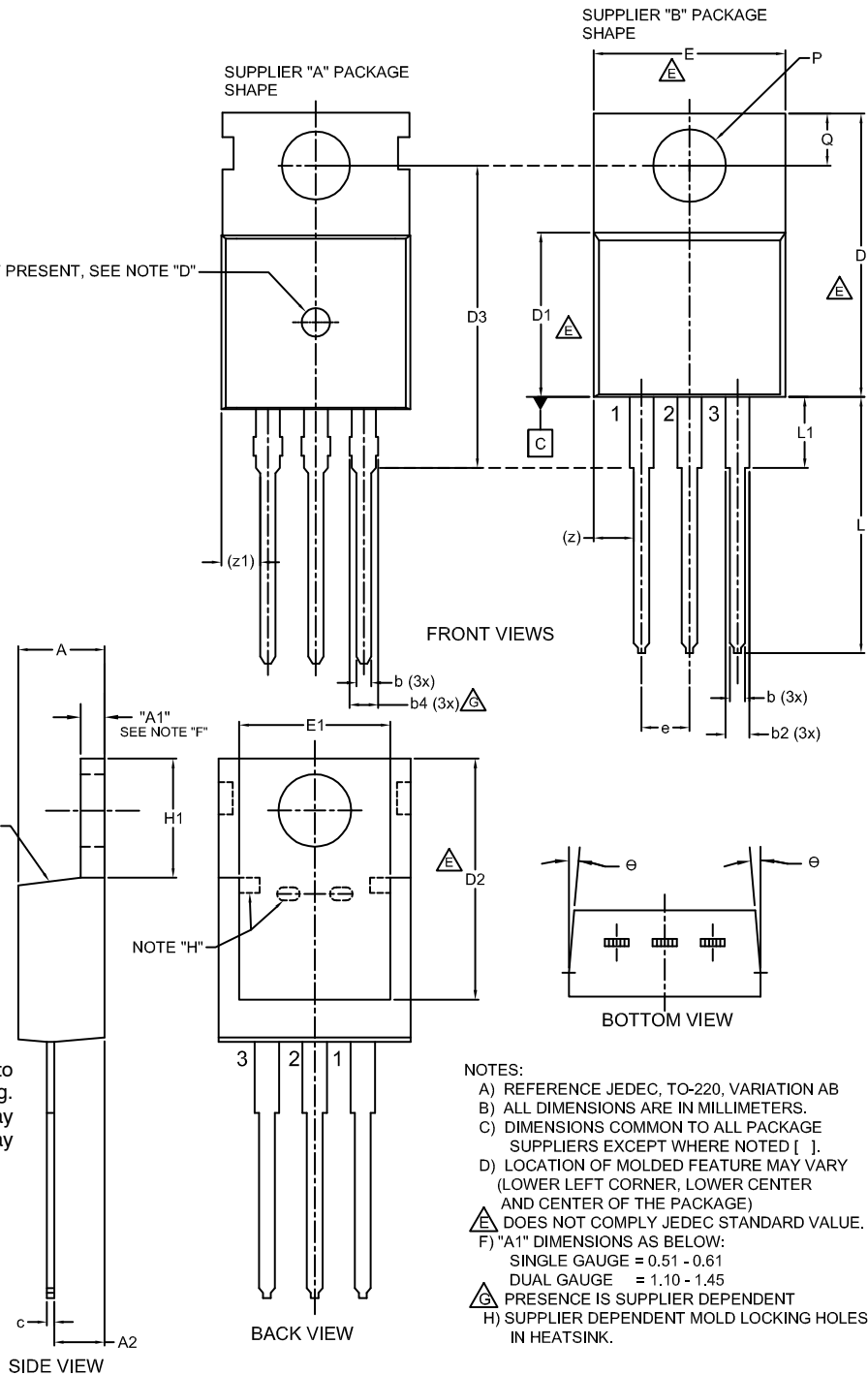
IF PRESENT, SEE NOTE "D"

### 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)
- 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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