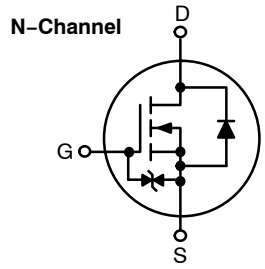
# MOSFET – N-Channel, UniFET™ II

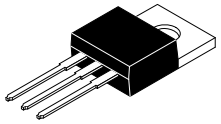
## 600 V, 12 A, 650 mΩ

# FDP12N60NZ, FDPF12N60NZ

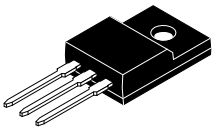
| $V_{DS}$ | $R_{DS(ON)}$ MAX | $I_D$ MAX |
|---|---|---|
| 600 V | 650 mΩ @ 10 V | 12 A* |

*Drain current limited by maximum junction temperature.



**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.

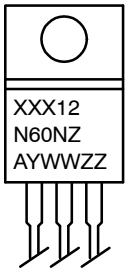
### Features

- $R_{DS(on)}$ = 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 |

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**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. $I_{SD}$ ≤ 12 A, di/dt ≤ 200 A/μs, $V_{DD}$ ≤ $BV_{DSS}$, 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 | |


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**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.



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## TYPICAL PERFORMANCE CHARACTERISTICS ($T_J$ = 25°C unless otherwise noted)

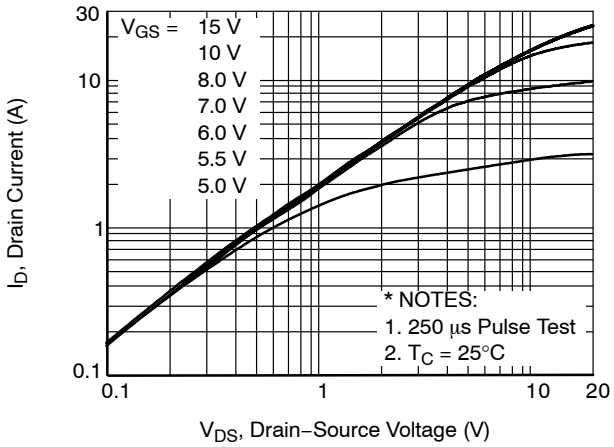



**Figure 1. On−Region Characteristics**

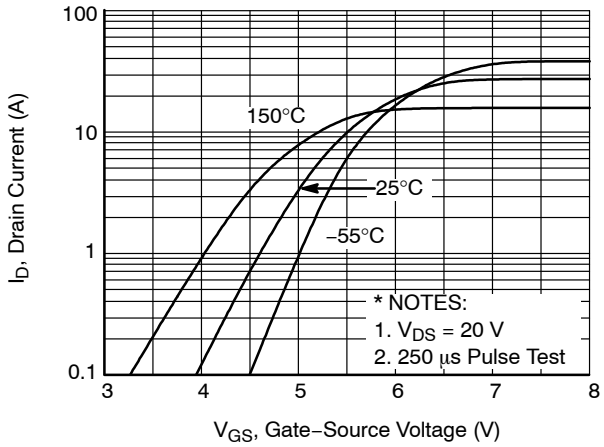



**Figure 2. Transfer Characteristics**

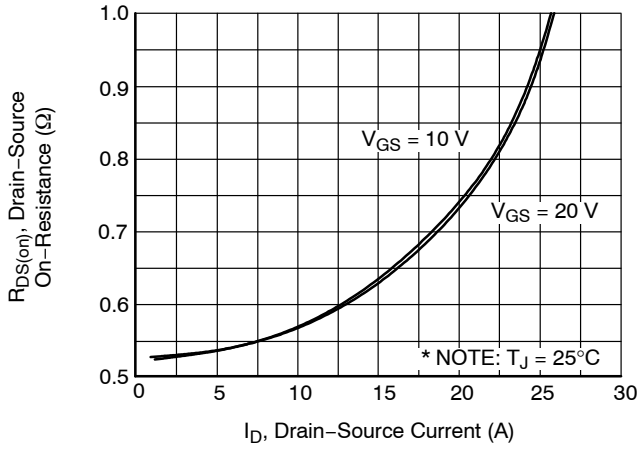



**Figure 3. On−Resistance Variation vs. Drain Current and Gate Voltage**

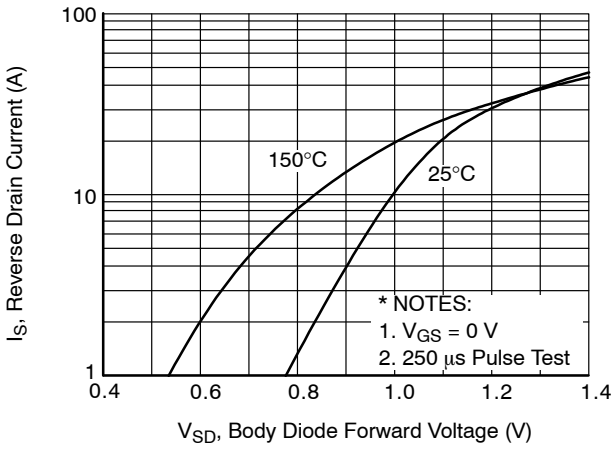



**Figure 4. Body Diode Forward Voltage Variation vs. Source Current And Temperature**

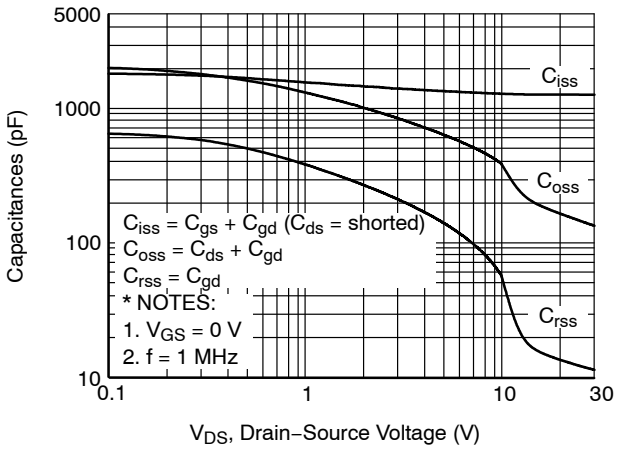



**Figure 5. Capacitance Characteristics**

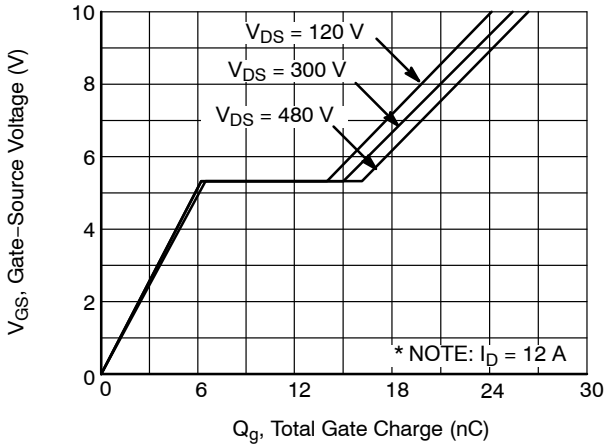



**Figure 6. Gate Charge Characteristics**



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## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

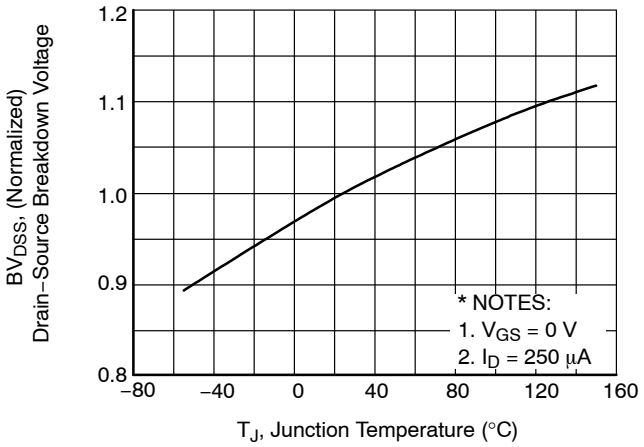



**Figure 7. Breakdown Voltage Variation vs. Temperature**

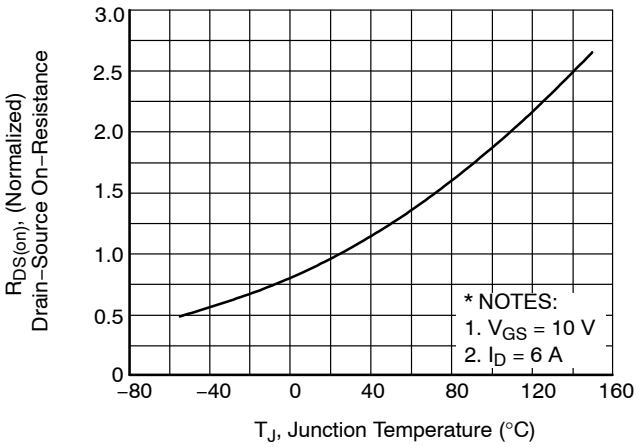



**Figure 8. On−Resistance Variation vs. Temperature**

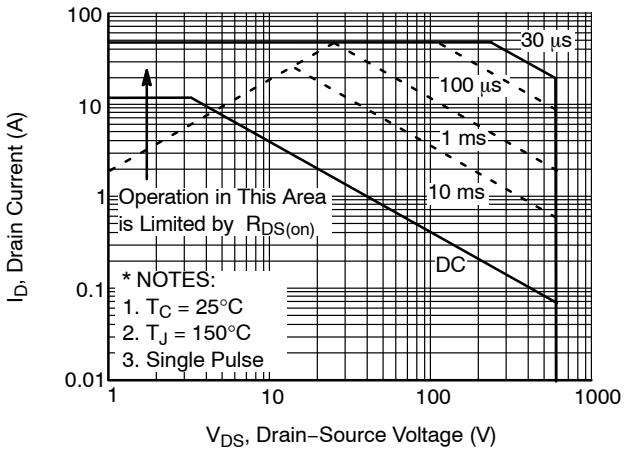



**Figure 9. Maximum Safe Operating Area − FDPF12N60NZ**

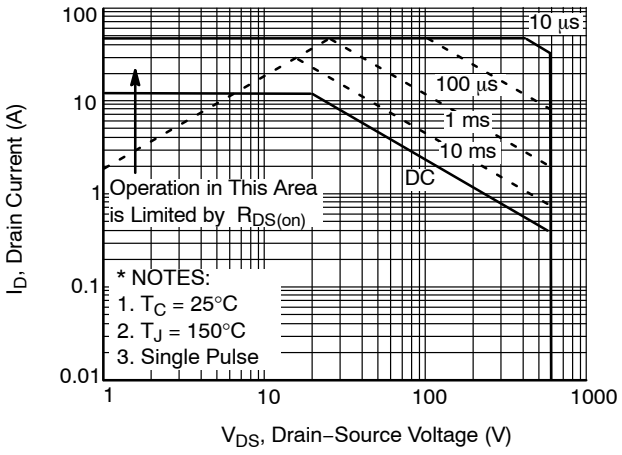



**Figure 10. Maximum Safe Operating Area − FDP12N60NZ**

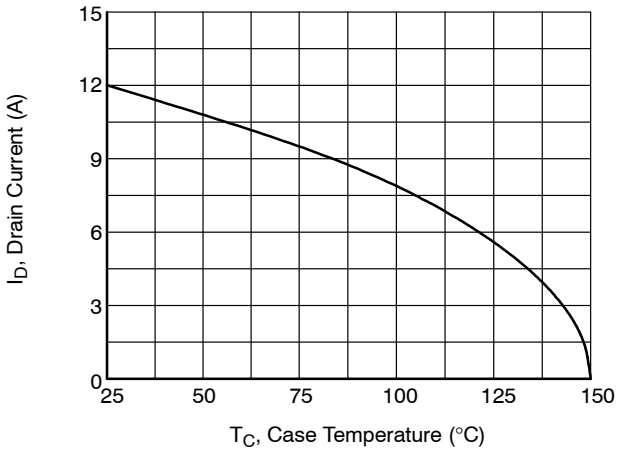



**Figure 11. Maximum Drain Current vs. Case Temperature**



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## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

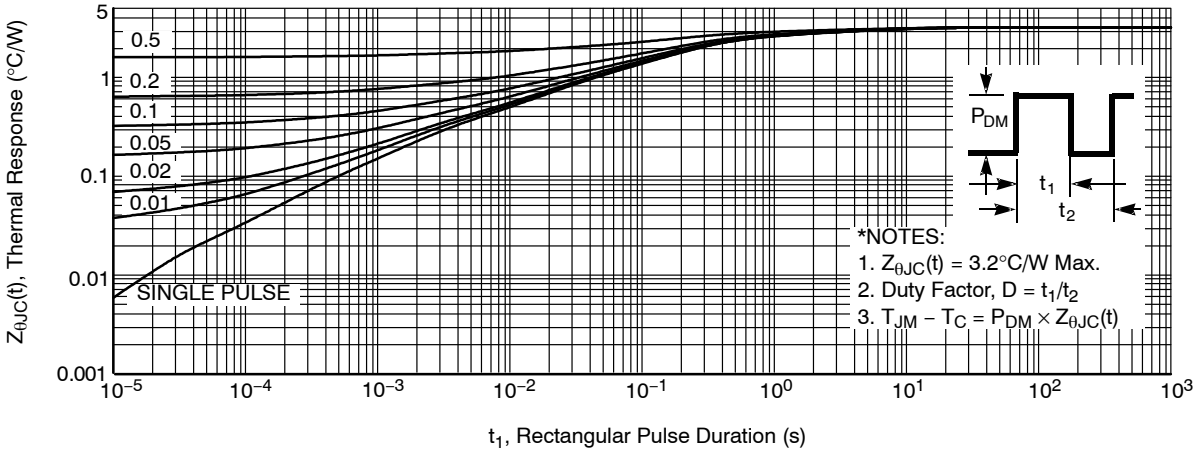



**Figure 12. Transient Thermal Response Curve for FDPF12N60NZ**

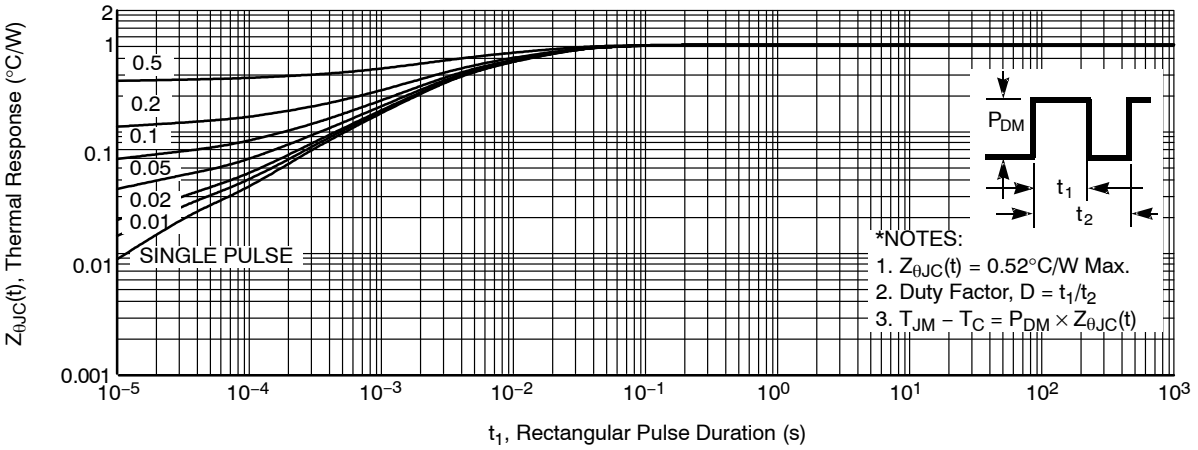



**Figure 13. Transient Thermal Response Curve for FDP12N60NZ**



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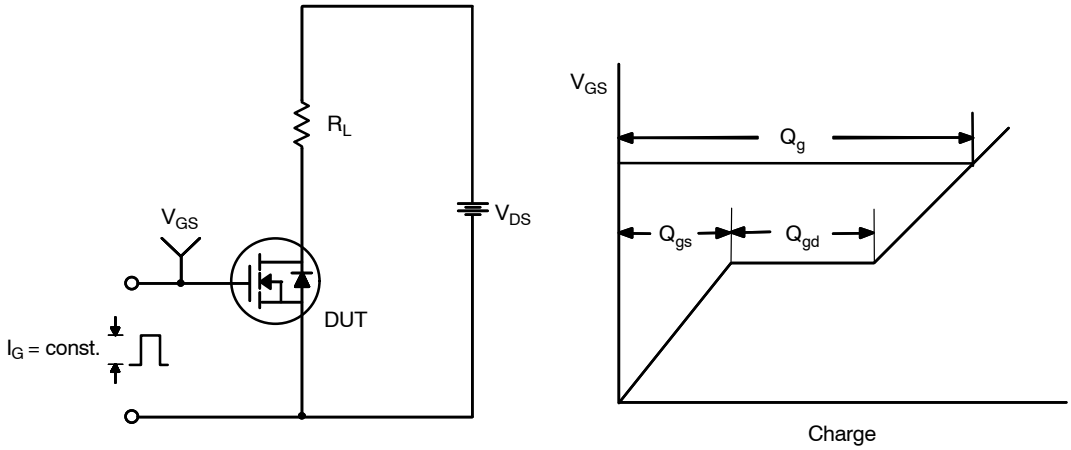



**Figure 14. Gate Charge Test Circuit & Waveform**

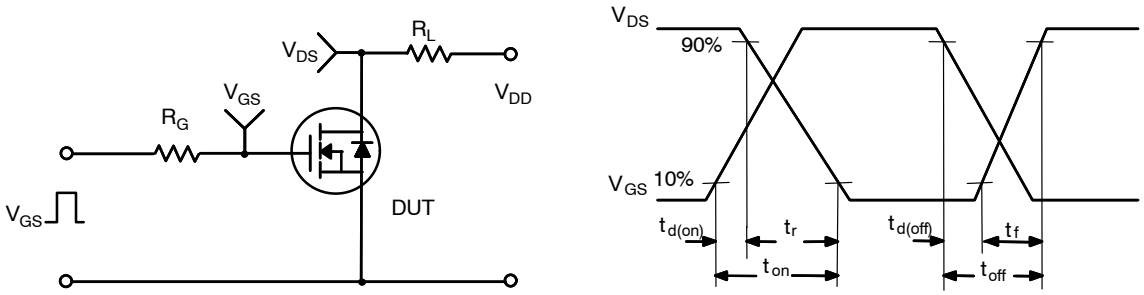



**Figure 15. Resistive Switching Test Circuit & Waveforms**

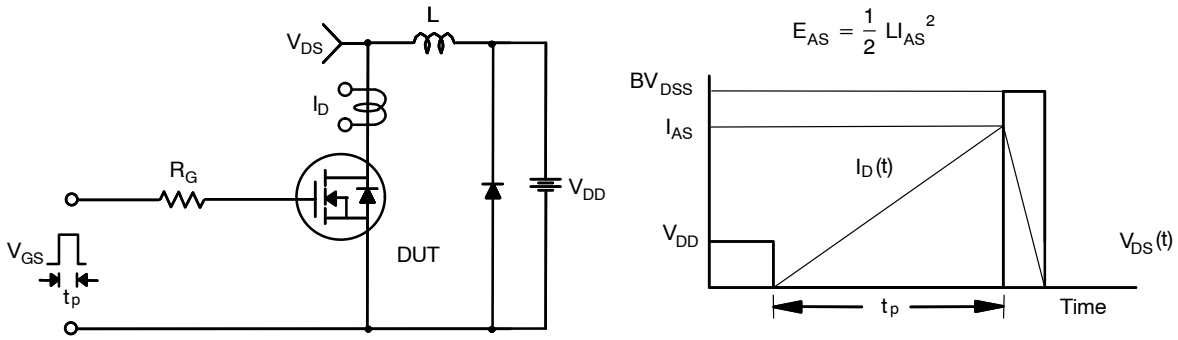



**Figure 16. Unclamped Inductive Switching Test Circuit & Waveforms**



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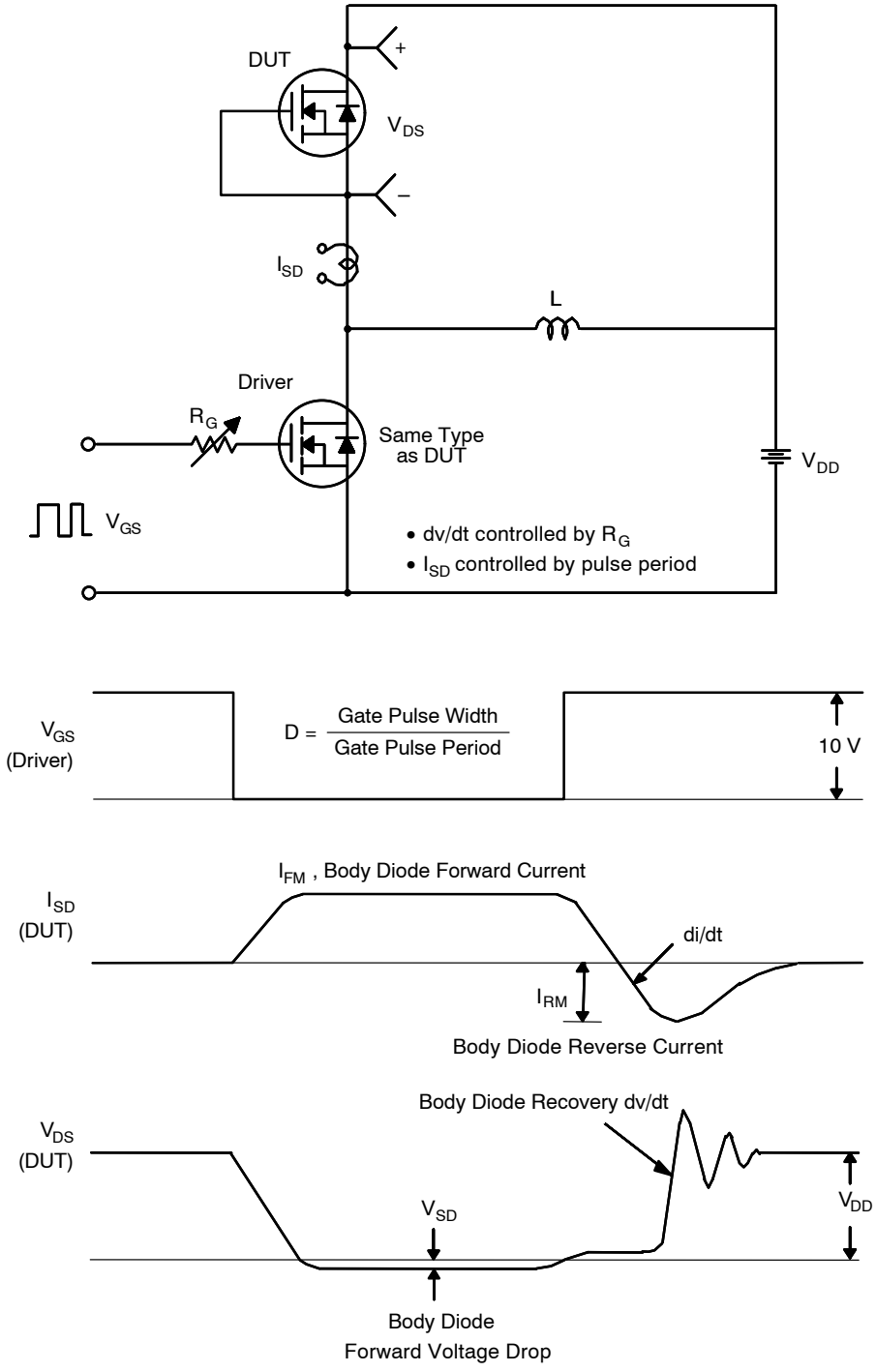



**Figure 17. Peak Diode Recovery dv/dt Test Circuit & Waveforms**

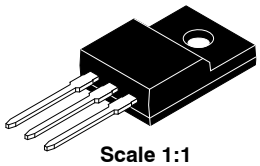
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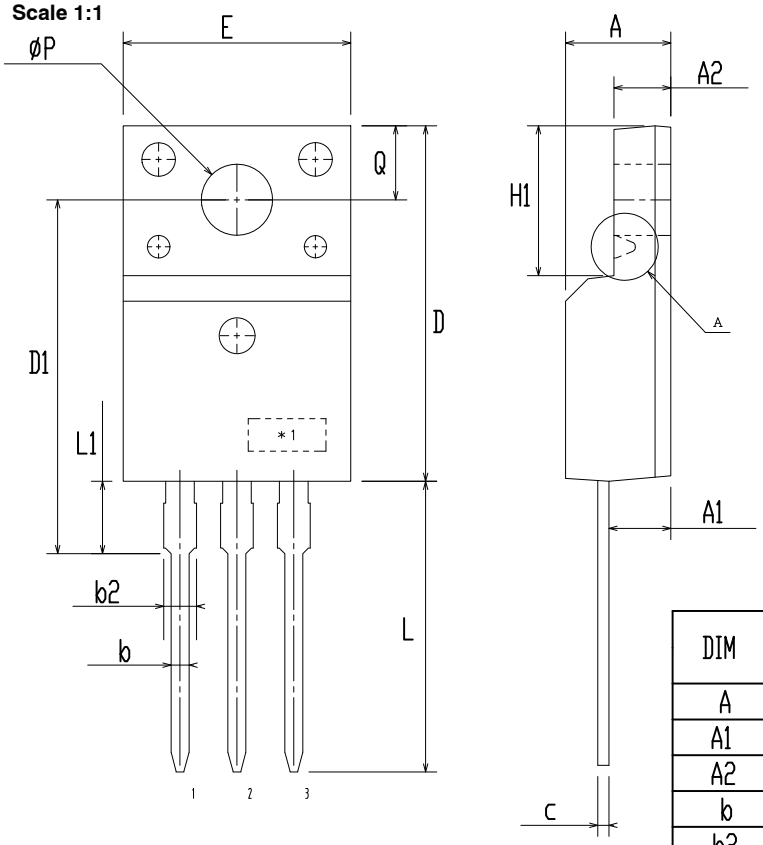
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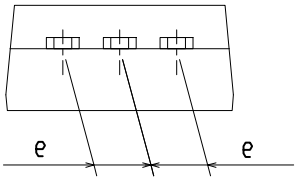
**TO−220 Fullpack, 3−Lead / TO−220F−3SG**
CASE 221AT
ISSUE B

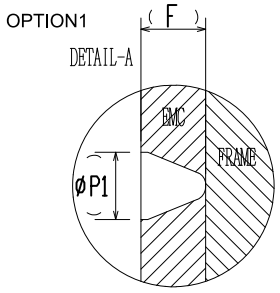
DATE 19 JAN 2021



**Scale 1:1**



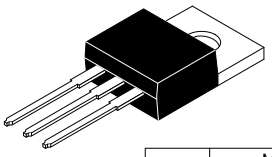

| DIM | MILLIMITERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.50 | 4.70 | 4.90 |
| A1 | 2.56 | 2.76 | 2.96 |
| A2 | 2.34 | 2.54 | 2.74 |
| b | 0.70 | 0.80 | 0.90 |
| b2 | ~ | ~ | 1.47 |
| c | 0.45 | 0.50 | 0.60 |
| D | 15.67 | 15.87 | 16.07 |
| D1 | 15.60 | 15.80 | 16.00 |
| E | 9.96 | 10.16 | 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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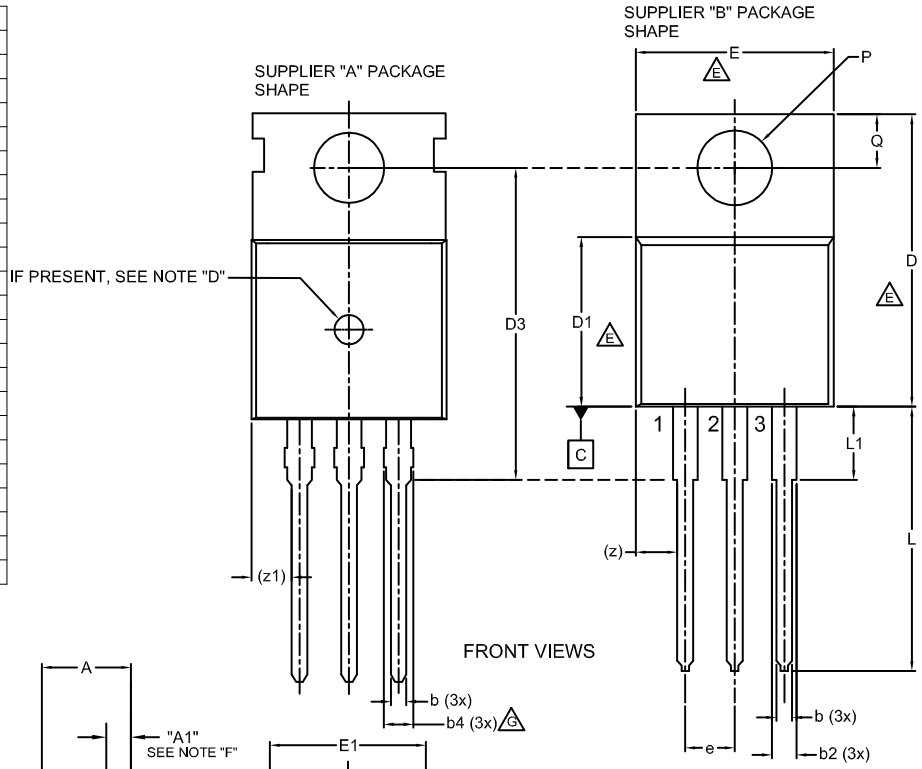
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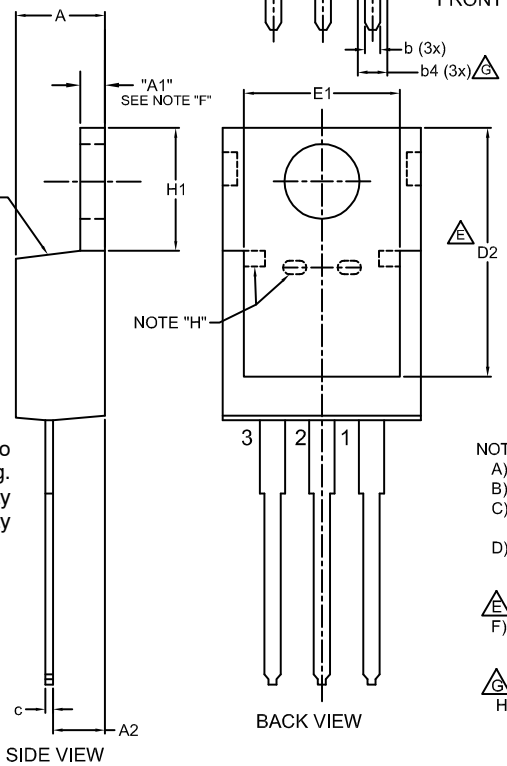


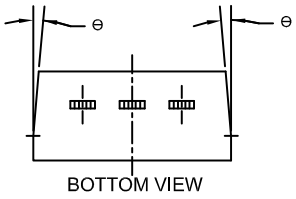
**TO−220−3LD**
CASE 340AT
ISSUE B

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)
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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