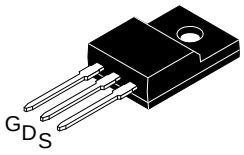
# MOSFET – N-Channel, SUPERFET® II, Easy-Drive

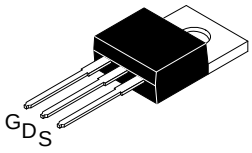
## 600 V, 10.2 A, 380 mΩ

# FCP380N60E, FCPF380N60E

| $V_{DSS}$ | $R_{DS(on)}$ MAX | $I_D$ 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**

### 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.

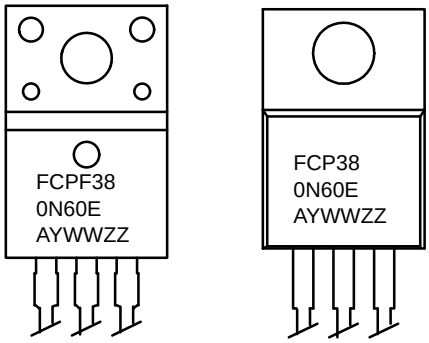
### Features

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

### Applications

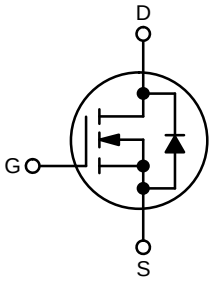
- LCD / LED / PDP TV Lighting
- Solar Inverter
- AC−DC Power Supply

### MARKING DIAGRAM




| | |
|---|---|
| FCP380N60E, FCPF380N60E | = Specific Device Code |
| 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 |

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**ABSOLUTE MAXIMUM RATINGS** ($T_C$ = 25°C, unless otherwise noted)

| Symbol | Parameter | | FCP380N60E | FCPF380N60E | Unit |
|---|---|---|---|---|---|
| $V_{DSS}$ | Drain to Source Voltage | | 600 | | V |
| $V_{GSS}$ | Gate to Source Voltage | − DC | ±20 | | V |
| | | − AC (f > 1 Hz) | ±30 | | |
| $I_D$ | Drain Current | − Continuous ($T_C$ = 25°C) | 10.2 | 10.2* | A |
| | | − Continuous ($T_C$ = 100°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°C) | 106 | 31 | W |
| | | − Derate Above 25°C | 0.85 | 0.25 | 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. $I_{AS}$ = 2.3 A, $V_{DD}$ = 50 V, $R_G$ = 25 Ω, starting $T_J$ = 25°C.
3. $I_{SD}$ ≤ 5.1 A, di/dt ≤ 200 A/μs, $V_{DD}$ ≤ $BV_{DSS}$, starting $T_J$ = 25°C.

**THERMAL CHARACTERISTICS**

| Symbol | Parameter | FCP380N60E | FCPF380N60E | Unit |
|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max. | 1.18 | 4 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 62.5 | 62.5 | |


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**ELECTRICAL CHARACTERISTICS** ($T_C$ = 25°C unless otherwise noted)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| $BV_{DSS}$ | Drain to Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 10 mA, $T_J$ = 25°C | 600 | – | – | V |
| | | $V_{GS}$ = 0 V, $I_D$ = 10 mA, $T_J$ = 150°C | 650 | – | – | V |
| $\Delta BV_{DSS}$ / $\Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 10 mA, Referenced to 25°C | – | 0.67 | – | V/°C |
| $BV_{DS}$ | Drain to Source Avalanche Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 10 A | – | 700 | – | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 600 V, $V_{GS}$ = 0 V | – | – | 1 | μA |
| | | $V_{DS}$ = 480 V, $T_C$ = 125°C | – | 0.84 | – | |
| $I_{GSS}$ | Gate to Body Leakage Current | $V_{GS}$ = ±20 V, $V_{DS}$ = 0 V | – | – | ±100 | nA |
| **ON CHARACTERISTICS** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 250 μA | 2.5 | – | 3.5 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS}$ = 10 V, $I_D$ = 5 A | – | 0.32 | 0.38 | Ω |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 20 V, $I_D$ = 5 A | – | 10 | – | S |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1 MHz | – | 1330 | 1770 | pF |
| $C_{oss}$ | Output Capacitance | | – | 945 | 1260 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | – | 60 | 90 | pF |
| $C_{oss}$ | Output Capacitance | $V_{DS}$ = 380 V, $V_{GS}$ = 0 V, f = 1 MHz | – | 25 | – | pF |
| $C_{oss(eff.)}$ | Effective Output Capacitance | $V_{DS}$ = 0 V to 480 V, $V_{GS}$ = 0 V | – | 97 | – | pF |
| $Q_{g(tot)}$ | Total Gate Charge at 10 V | $V_{DS}$ = 380 V, $I_D$ = 5 A, $V_{GS}$ = 10 V (Note 4) | – | 34 | 45 | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | – | 5.3 | – | nC |
| $Q_{gd}$ | Gate to Drain “Miller” Charge | | – | 13 | – | nC |
| ESR | Equivalent Series Resistance | f = 1 MHz | – | 6 | – | Ω |
| **SWITCHING CHARACTERISTICS** | | | | | | |
| $t_{d(on)}$ | Turn−On Delay Time | $V_{DD}$ = 380 V, $I_D$ = 5 A, $V_{GS}$ = 10 V, R = 4.7 Ω (Note 4) | – | 17 | 44 | ns |
| $t_r$ | Turn−On Rise Time | | – | 9 | 28 | ns |
| $t_{d(off)}$ | Turn−Off Delay Time | | – | 64 | 138 | ns |
| $t_f$ | Turn−Off Fall Time | | – | 10 | 30 | ns |
| **DRAIN−SOURCE DIODE CHARACTERISTICS** | | | | | | |
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | – | – | 10.2 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | – | – | 30.6 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 5 A | – | – | 1.2 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0 V, $I_{SD}$ = 5 A, $dI_F/dt$ = 100 A/μs | – | 240 | – | ns |
| $Q_{rr}$ | 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.



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## TYPICAL PERFORMANCE CHARACTERISTICS

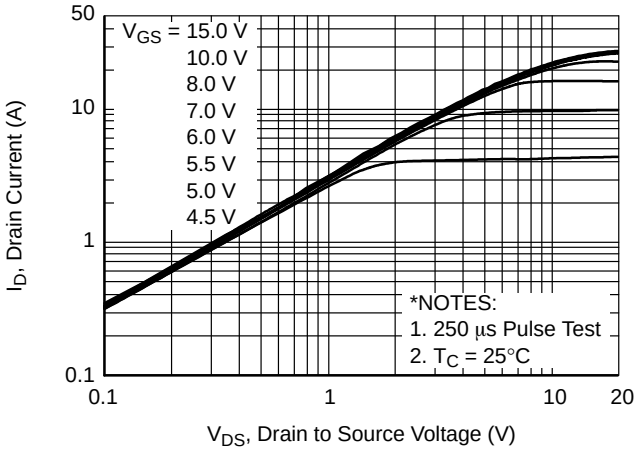



**Figure 1. On−Region Characteristics**

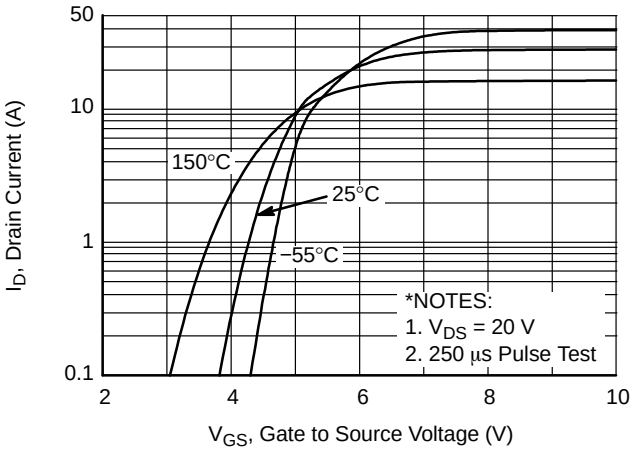



**Figure 2. Transfer Characteristics**

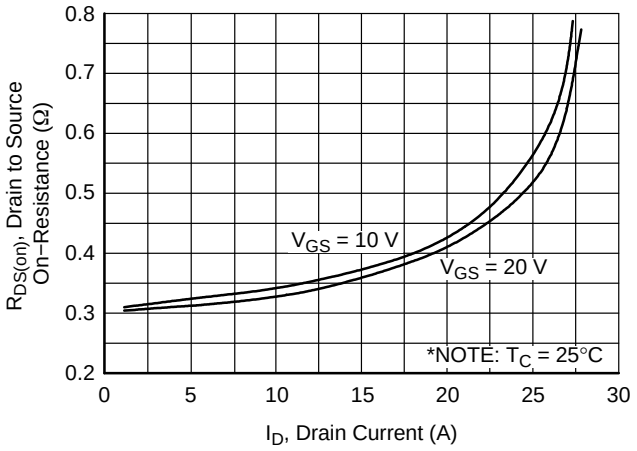



**Figure 3. On−Resistance Variation vs. Drain Current and Gate Voltage**

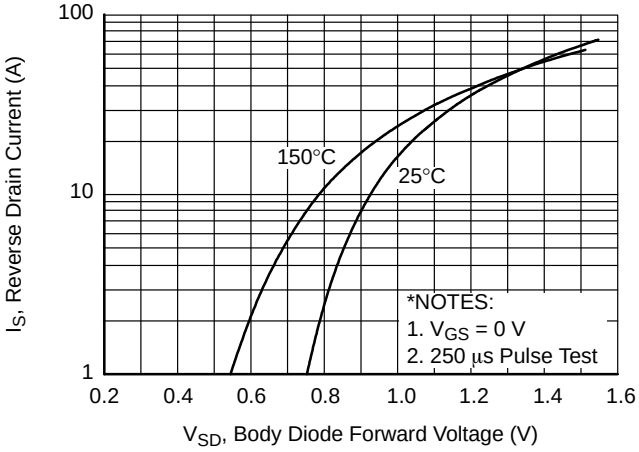



**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**

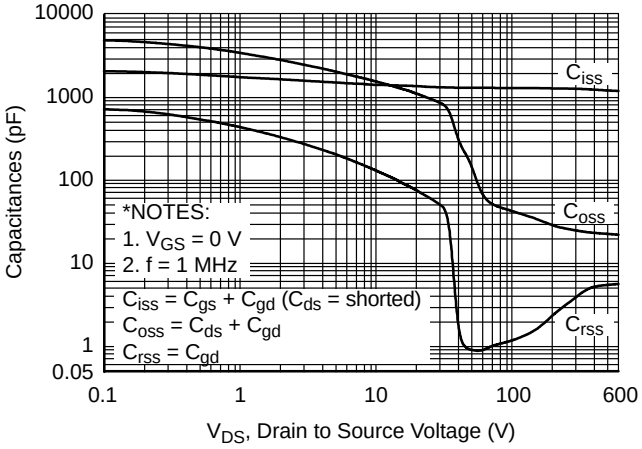



**Figure 5. Capacitance Characteristics**

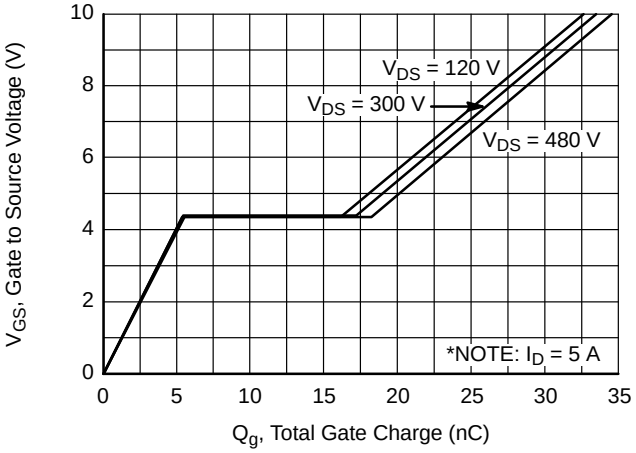



**Figure 6. Gate Charge Characteristics**



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## TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

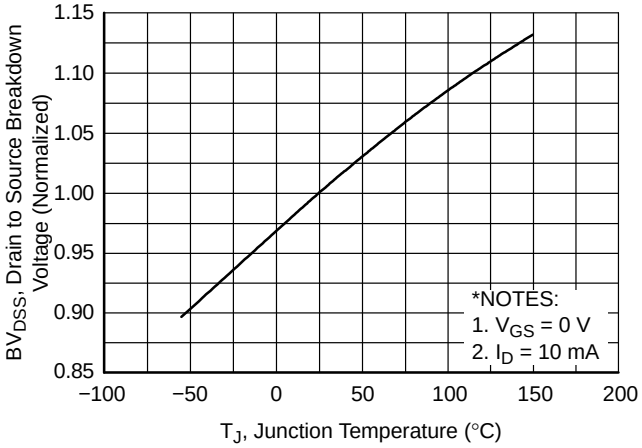



**Figure 7. Breakdown Voltage Variation vs. Temperature**

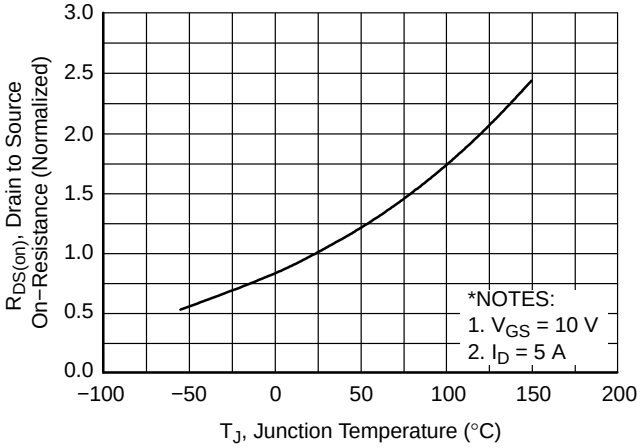



**Figure 8. On−Resistance Variation vs. Temperature**

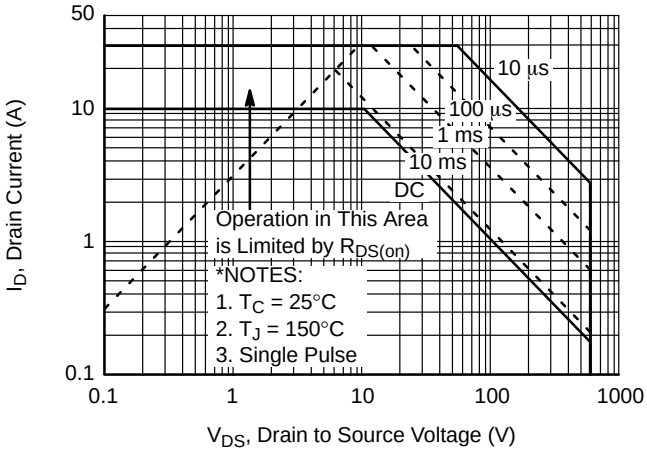



**Figure 9. Maximum Safe Operating Area for FCP380N60E**

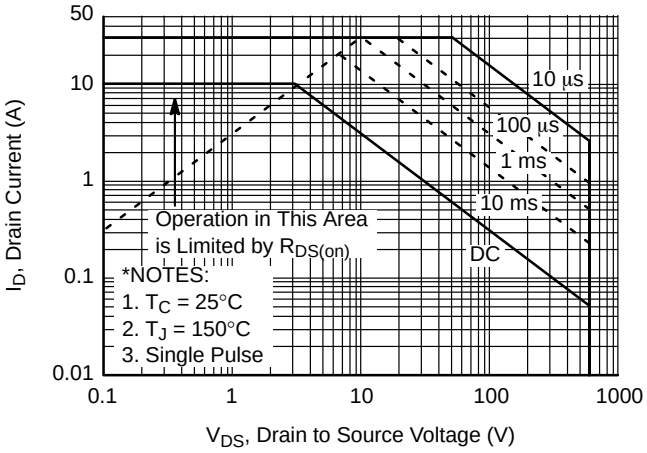



**Figure 10. Maximum Safe Operating Area for FCPF380N60E**

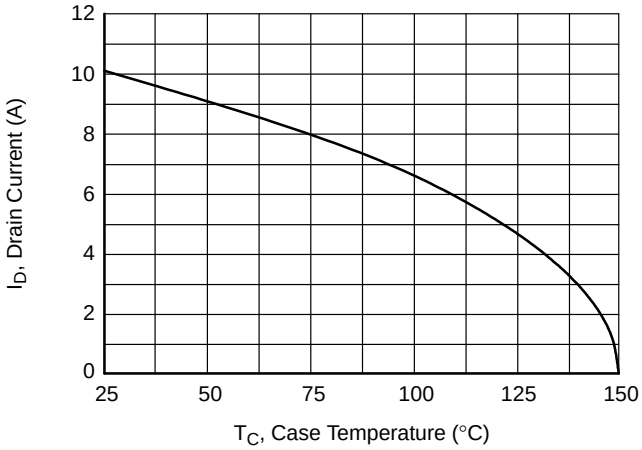



**Figure 11. Maximum Drain Current vs. Case Temperature**

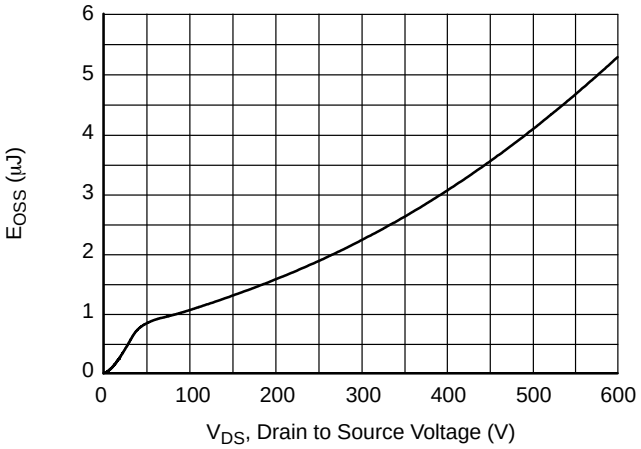



**Figure 12. $E_{OSS}$ vs. Drain to Source Voltage**



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## TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

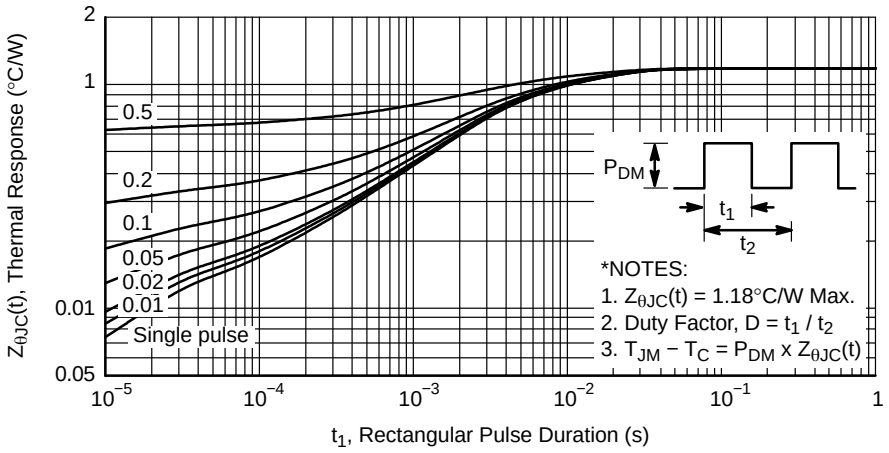



**Figure 13. Transient Thermal Response Curve for FCP380N60E**

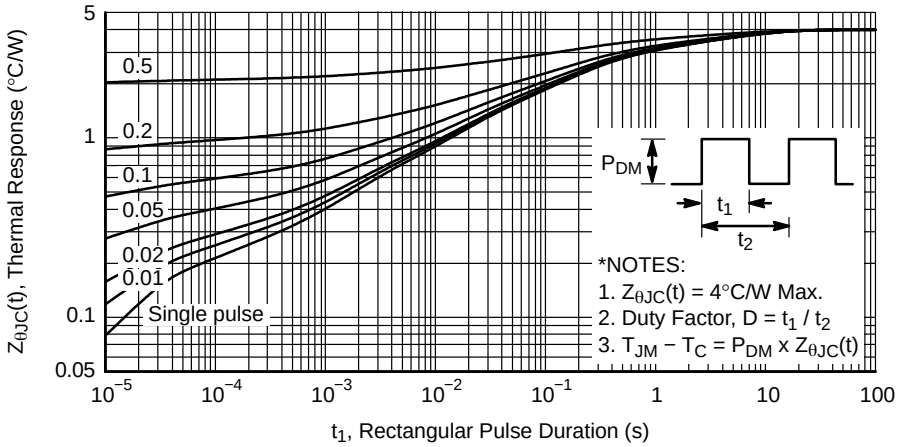



**Figure 14. Transient Thermal Response Curve for FCPF380N60E**



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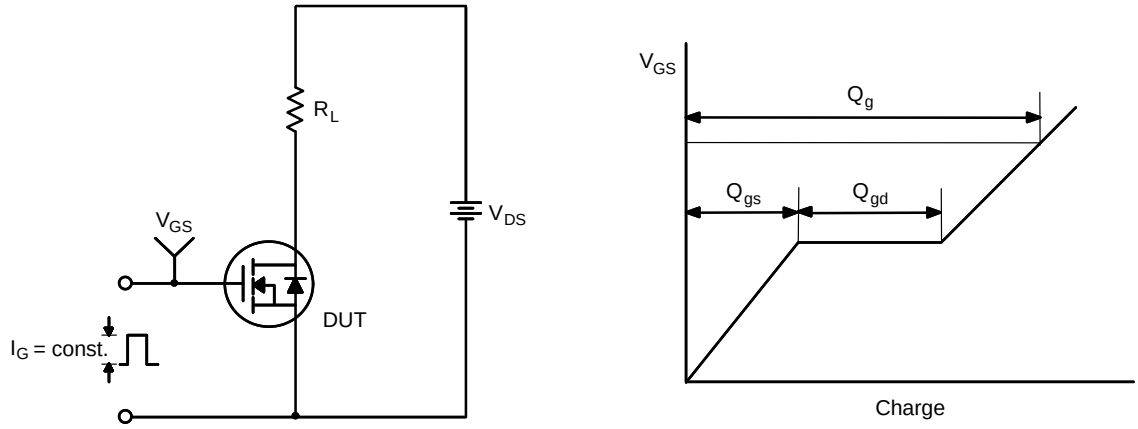



**Figure 15. Gate Charge Test Circuit & Waveform**

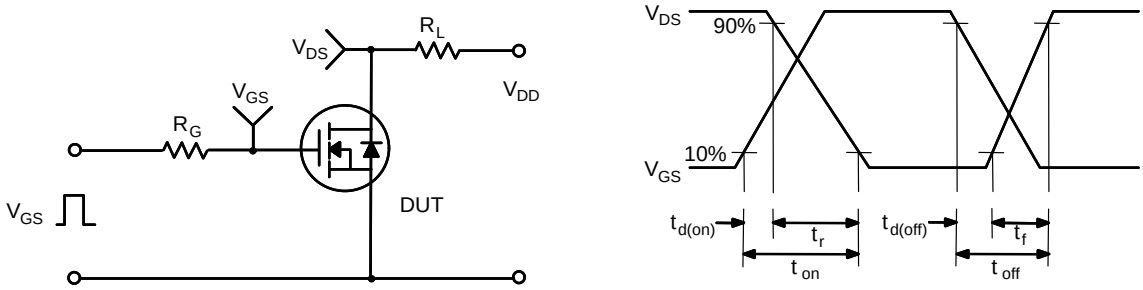



**Figure 16. Resistive Switching Test Circuit & Waveforms**

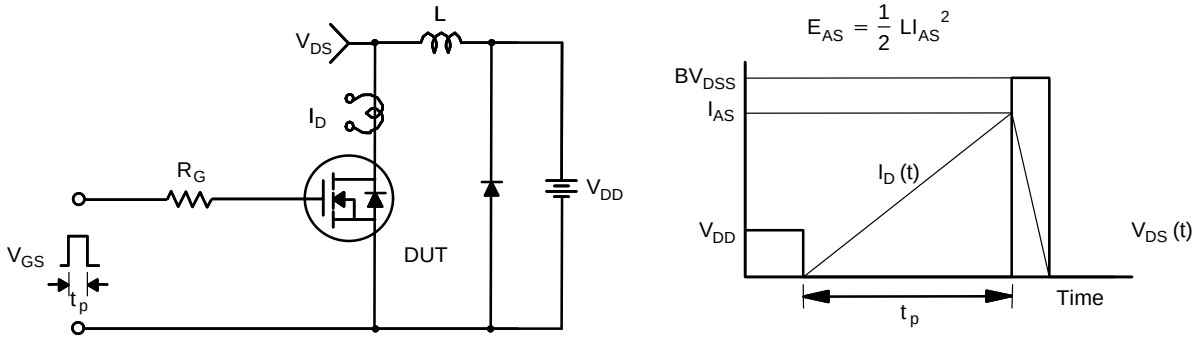



**Figure 17. Unclamped Inductive Switching Test Circuit & Waveforms**



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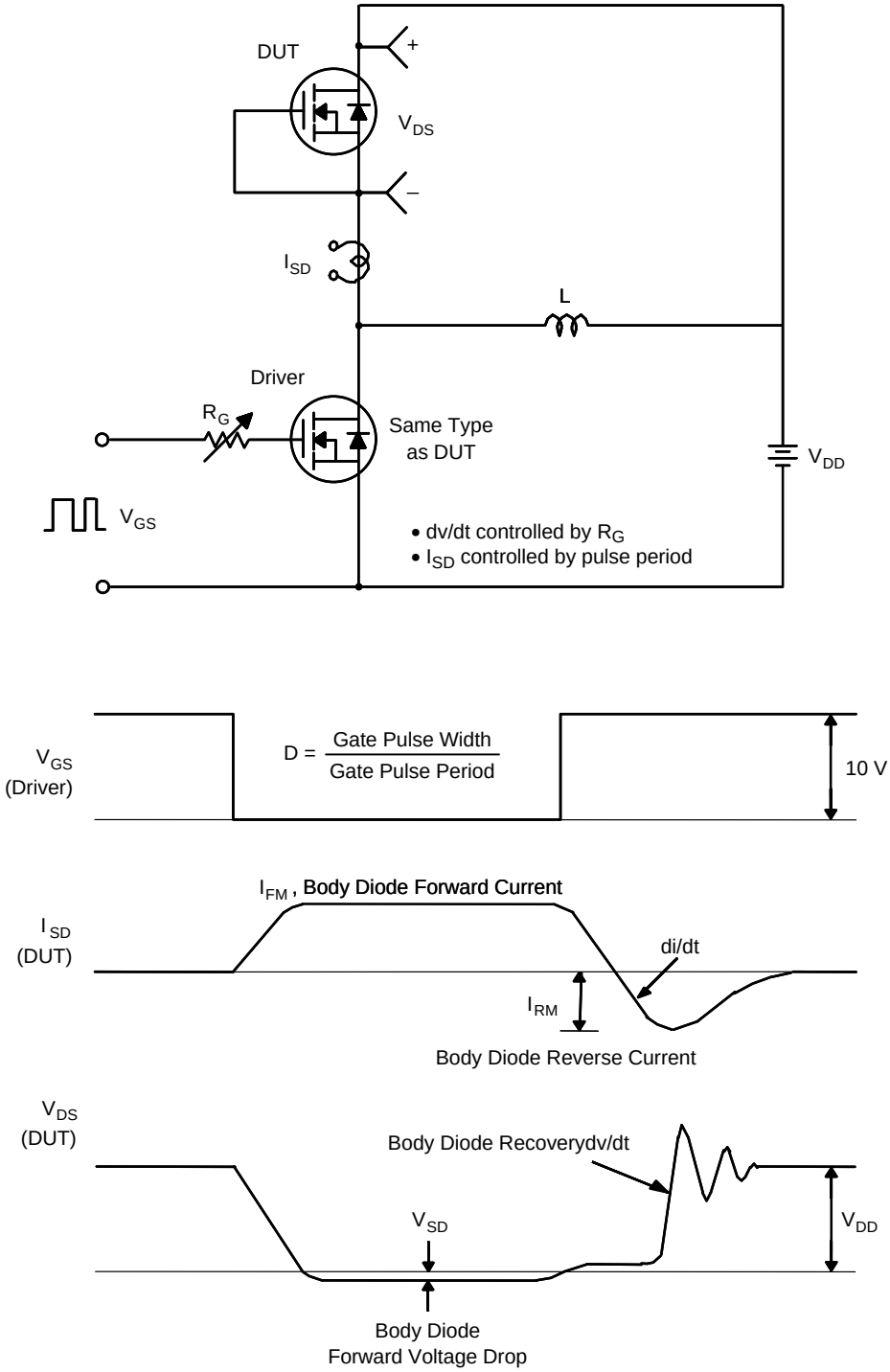



**Figure 18. Peak Diode Recovery dv/dt Test Circuit & Waveforms**

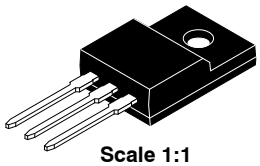
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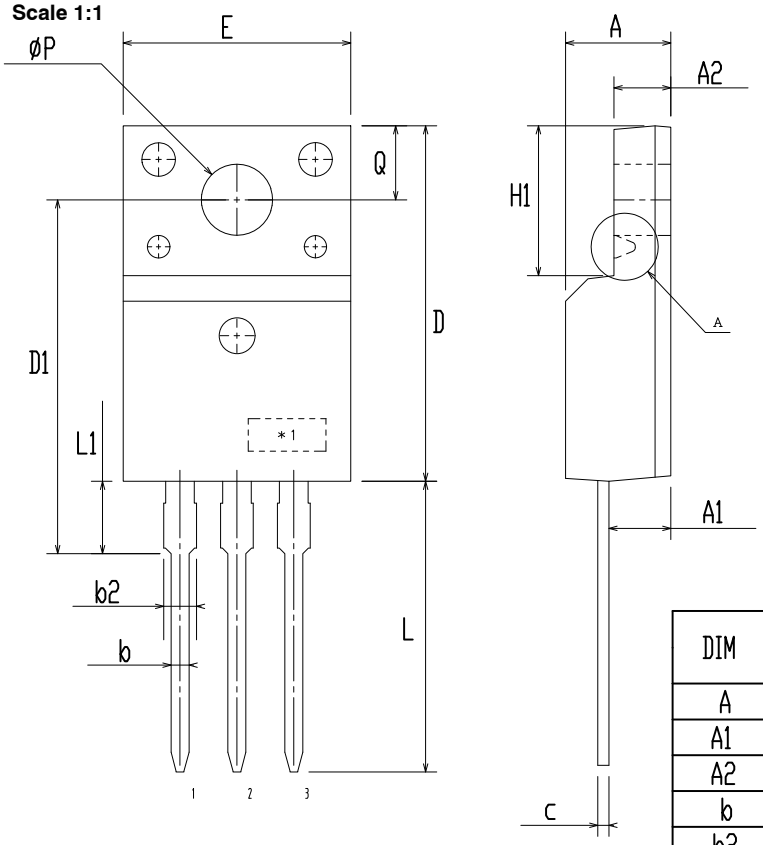
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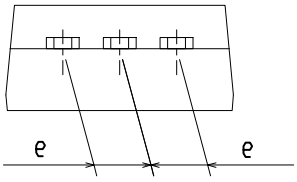
**TO−220 Fullpack, 3−Lead / TO−220F−3SG**
CASE 221AT
ISSUE B

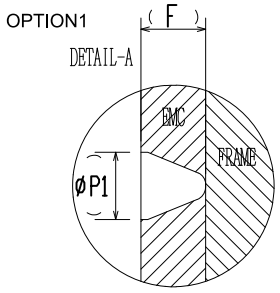
DATE 19 JAN 2021



**Scale 1:1**



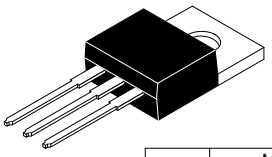




| DIM | MILLIMITERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.50 | 4.70 | 4.90 |
| A1 | 2.56 | 2.76 | 2.96 |
| A2 | 2.34 | 2.54 | 2.74 |
| b | 0.70 | 0.80 | 0.90 |
| b2 | ~ | ~ | 1.47 |
| c | 0.45 | 0.50 | 0.60 |
| D | 15.67 | 15.87 | 16.07 |
| D1 | 15.60 | 15.80 | 16.00 |
| E | 9.96 | 10.16 | 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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| **DESCRIPTION:** | **TO−220 FULLPACK, 3−LEAD / TO−220F−3SG** | | **PAGE 1 OF 1** |

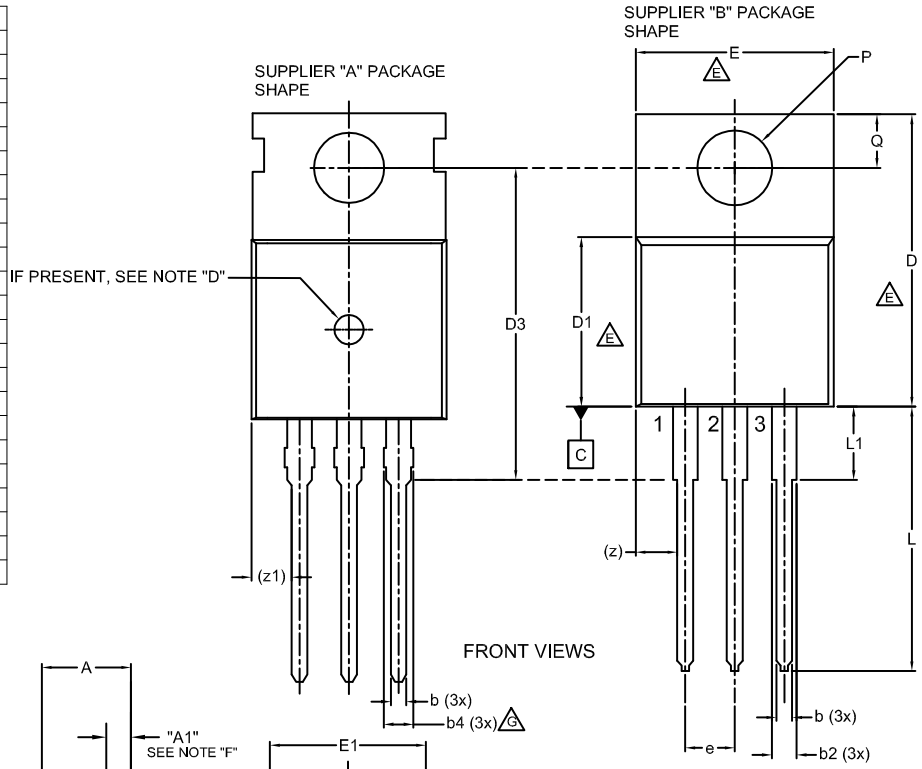
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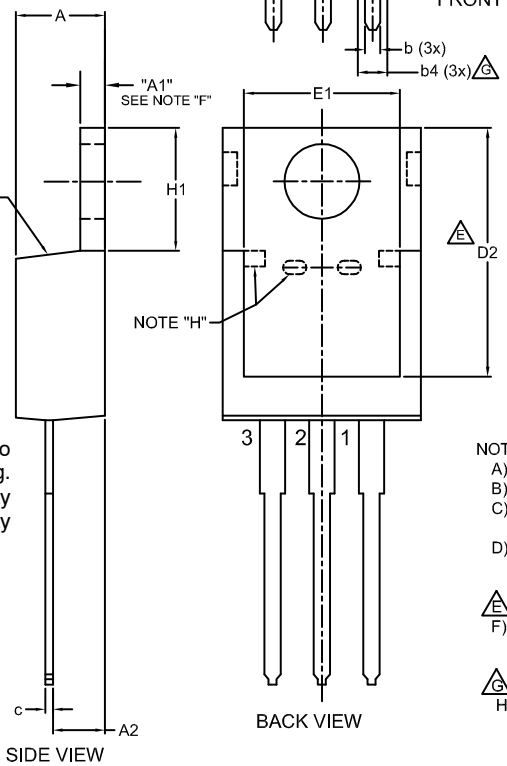


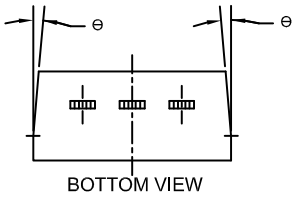
**TO−220−3LD**
CASE 340AT
ISSUE B

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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| **DESCRIPTION:** | **TO−220−3LD** | | **PAGE 1 OF 1** |

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