

# MOSFET – N-Channel, SUPERFET<sup>®</sup>, FRFET<sup>®</sup>

600 V, 11 A, 380 mΩ

## FCPF11N60F

### Description

SUPERFET MOSFET is onsemi's first generation of 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 MOSFET is very suitable for the switching power applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications. SUPERFET FRFET MOSFET's optimized body diode reverse recovery performance can remove additional component and improve system reliability.

### Features

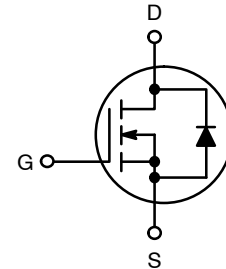
- 600 V @  $T_J = 150^{\circ}\text{C}$
- $R_{DS(on)} = 320\text{ m}\Omega$  (Typ.)
- Fast Recovery Type ( $t_{rr} = 120\text{ ns}$ )
- Ultra Low Gate Charge (Typ.  $Q_g = 40\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 95\text{ pF}$ )
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

### Applications

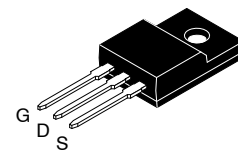
- LCD/LED/PDP TV
- Lighting
- Solar Inverter
- AC-DC Power Supply

| $V_{DS}$ | $R_{DS(on)}\text{ MAX}$ | $I_D\text{ MAX}$ |
|----------|-------------------------|------------------|
| 600 V    | 380 mΩ @ 10 V           | 11 A*            |

\*Drain current limited by maximum junction temperature.

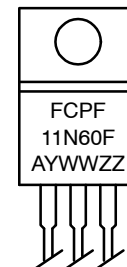


N-Channel



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

### MARKING DIAGRAM



FCPF11N60F = Specific Device Code  
A = Assembly Location  
YWW = Date Code (Year & Week)  
ZZ = Assembly Lot

### ORDERING INFORMATION

| Device     | Package          | Shipping          |
|------------|------------------|-------------------|
| FCPF11N60F | TO-220-3 FULLPAK | 1000 Units / Tube |

# FCPF11N60F

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

| Symbol         | Parameter                                                               |                                            | FCPF11N60F      | Unit                |
|----------------|-------------------------------------------------------------------------|--------------------------------------------|-----------------|---------------------|
| $V_{DSS}$      | Drain to Source Voltage                                                 |                                            | 600             | V                   |
| $I_D$          | Drain Current                                                           | – Continuous ( $T_C = 25^\circ\text{C}$ )  | 11*             | A                   |
|                |                                                                         | – Continuous ( $T_C = 100^\circ\text{C}$ ) | 7*              |                     |
| $I_{DM}$       | Drain Current                                                           | – Pulsed (Note 1)                          | 33*             | A                   |
| $V_{GSS}$      | Gate to Source Voltage                                                  |                                            | $\pm 30$        | V                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                 |                                            | 340             | mJ                  |
| $I_{AR}$       | Avalanche Current (Note 1)                                              |                                            | 11              | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                    |                                            | 12.5            | mJ                  |
| $dv/dt$        | Peak Diode Recovery $dv/dt$ (Note 3)                                    |                                            | 4.5             | V/ns                |
| $P_D$          | Power Dissipation                                                       | ( $T_C = 25^\circ\text{C}$ )               | 36              | W                   |
|                |                                                                         | – Derate Above $25^\circ\text{C}$          | 0.29            | 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,<br>1/8" from Case for 5 Seconds |                                            | 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.  $I_{AS} = 5.5$  A,  $V_{DD} = 50$  V,  $R_G = 25$   $\Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 11$  A,  $di/dt \leq 200$  A/ $\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .

## THERMAL CHARACTERISTICS

| Symbol          | Parameter                                     | FCPF11N60F | Unit                      |
|-----------------|-----------------------------------------------|------------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 3.5        | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 62.5       | $^\circ\text{C}/\text{W}$ |

# FCPF11N60F

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

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

### OFF CHARACTERISTICS

|                                      |                                           |                                                                                    |     |     |           |               |
|--------------------------------------|-------------------------------------------|------------------------------------------------------------------------------------|-----|-----|-----------|---------------|
| BV <sub>DSS</sub>                    | Drain to Source Breakdown Voltage         | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 $\mu\text{A}$ , T <sub>C</sub> = 25°C  | 600 | –   | –         | V             |
|                                      |                                           | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 $\mu\text{A}$ , T <sub>C</sub> = 150°C | –   | 650 | –         | V             |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 250 $\mu\text{A}$ , Referenced to 25°C                            | –   | 0.6 | –         | V/°C          |
| BV <sub>DS</sub>                     | Drain–Source Avalanche Breakdown Voltage  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 11 A                                       | –   | 700 | –         | V             |
| I <sub>DSS</sub>                     | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V                                     | –   | –   | 1         | $\mu\text{A}$ |
|                                      |                                           | V <sub>DS</sub> = 480 V, T <sub>C</sub> = 125°C                                    | –   | –   | 10        |               |
| I <sub>GSS</sub>                     | Gate to Body Leakage Current              | V <sub>GS</sub> = $\pm 30$ V, V <sub>DS</sub> = 0 V                                | –   | –   | $\pm 100$ | nA            |

### ON CHARACTERISTICS

|                     |                                      |                                                                        |     |      |      |          |
|---------------------|--------------------------------------|------------------------------------------------------------------------|-----|------|------|----------|
| V <sub>GS(th)</sub> | Gate Threshold Voltage               | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250 $\mu\text{A}$ | 3.0 | –    | 5.0  | V        |
| R <sub>DS(on)</sub> | Static Drain to Source On–Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 5.5 A                         | –   | 0.32 | 0.38 | $\Omega$ |
| g <sub>FS</sub>     | Forward Transconductance             | V <sub>DS</sub> = 40 V, I <sub>D</sub> = 5.5 A                         | –   | 6    | –    | S        |

### DYNAMIC CHARACTERISTICS

|                        |                               |                                                                                 |   |      |      |    |
|------------------------|-------------------------------|---------------------------------------------------------------------------------|---|------|------|----|
| C <sub>iss</sub>       | Input Capacitance             | V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V, f = 1 MHz                        | – | 1148 | 1490 | pF |
| C <sub>oss</sub>       | Output Capacitance            |                                                                                 | – | 671  | 870  | pF |
| C <sub>rss</sub>       | Reverse Transfer Capacitance  |                                                                                 | – | 63   | 82   | pF |
| C <sub>oss</sub>       | Output Capacitance            | V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V, f = 1 MHz                       | – | 35   | –    | pF |
| C <sub>oss(eff.)</sub> | Effective Output Capacitance  | V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V                           | – | 95   | –    | pF |
| Q <sub>g(tot)</sub>    | Total Gate Charge at 10 V     | V <sub>DS</sub> = 480 V, I <sub>D</sub> = 11 A, V <sub>GS</sub> = 10 V (Note 4) | – | 40   | 52   | nC |
| Q <sub>gs</sub>        | Gate to Source Gate Charge    |                                                                                 | – | 7.2  | –    | nC |
| Q <sub>gd</sub>        | Gate to Drain “Miller” Charge |                                                                                 | – | 21   | –    | nC |

### SWITCHING CHARACTERISTICS

|                     |                     |                                                                                       |   |     |     |    |
|---------------------|---------------------|---------------------------------------------------------------------------------------|---|-----|-----|----|
| t <sub>d(on)</sub>  | Turn–On Delay Time  | V <sub>DD</sub> = 300 V, I <sub>D</sub> = 11 A, R <sub>G</sub> = 25 $\Omega$ (Note 4) | – | 34  | 80  | ns |
| t <sub>r</sub>      | Turn–On Rise Time   |                                                                                       | – | 98  | 205 | ns |
| t <sub>d(off)</sub> | Turn–Off Delay Time |                                                                                       | – | 119 | 250 | ns |
| t <sub>f</sub>      | Turn–Off Fall Time  |                                                                                       | – | 56  | 120 | ns |

### DRAIN–SOURCE DIODE CHARACTERISTICS

|                 |                                                          |                                                                               |   |     |     |    |
|-----------------|----------------------------------------------------------|-------------------------------------------------------------------------------|---|-----|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain to Source Diode Forward Current |                                                                               | – | –   | 11  | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain to Source Diode Forward Current     |                                                                               | – | –   | 33  | A  |
| V <sub>SD</sub> | Drain to Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 11 A                                 | – | –   | 1.4 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 11 A, dI <sub>F</sub> /dt = 100 A/μs | – | 120 | –   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  |                                                                               | – | 0.8 | –   | 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 PERFORMANCE CHARACTERISTICS

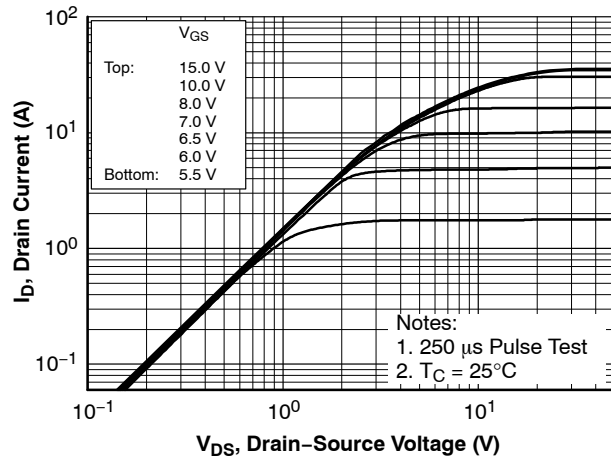


Figure 1. On-Region Characteristics

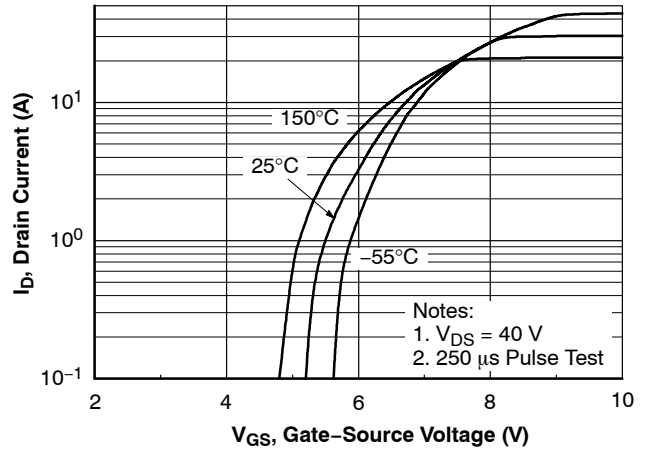


Figure 2. Transfer Characteristics

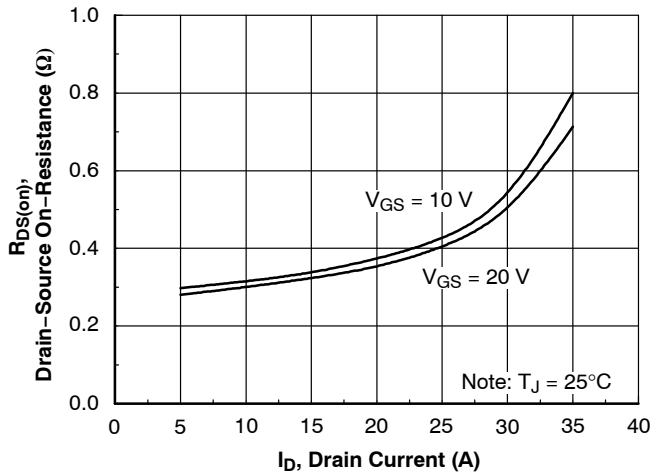


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

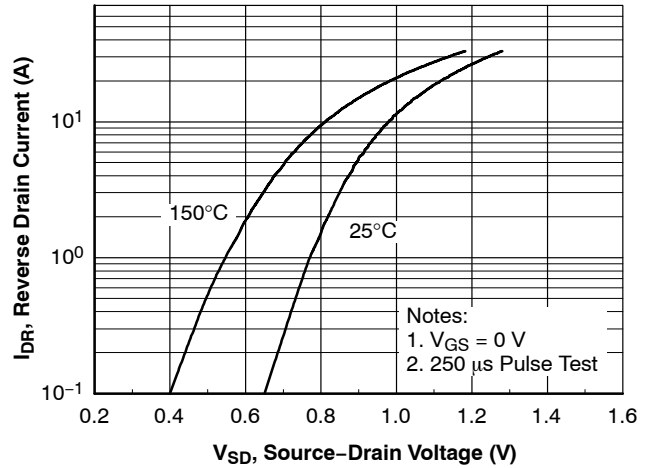


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

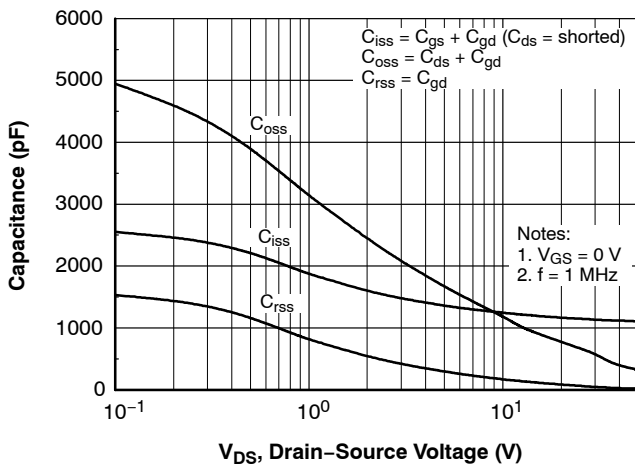


Figure 5. Capacitance Characteristics

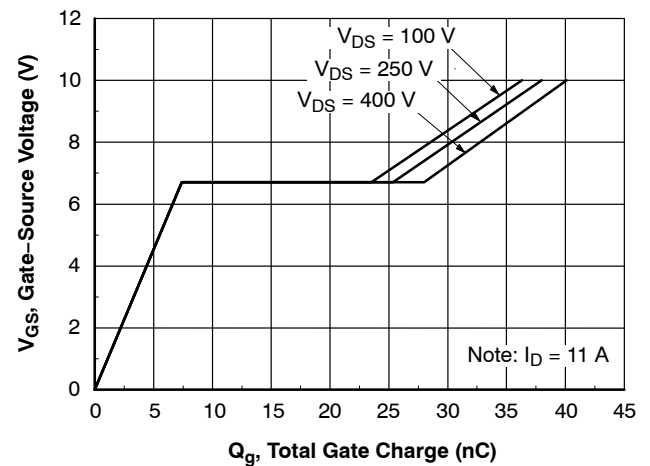


Figure 6. Gate Charge Characteristics

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

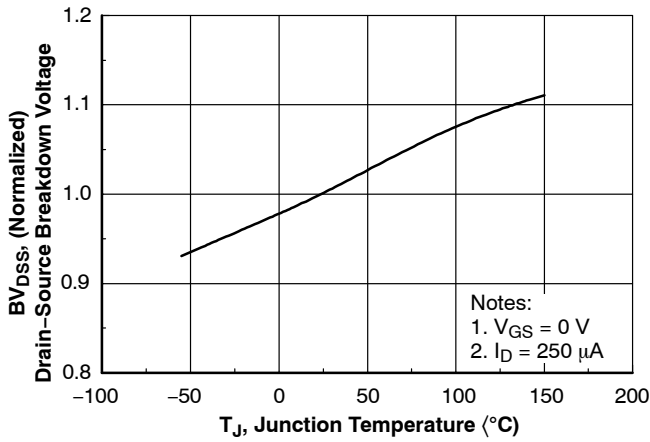


Figure 7. Breakdown Voltage Variation vs. Temperature

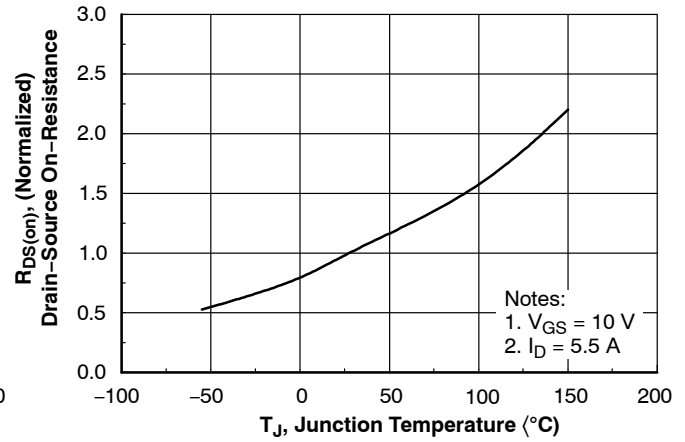


Figure 8. On-Resistance Variation vs. Temperature

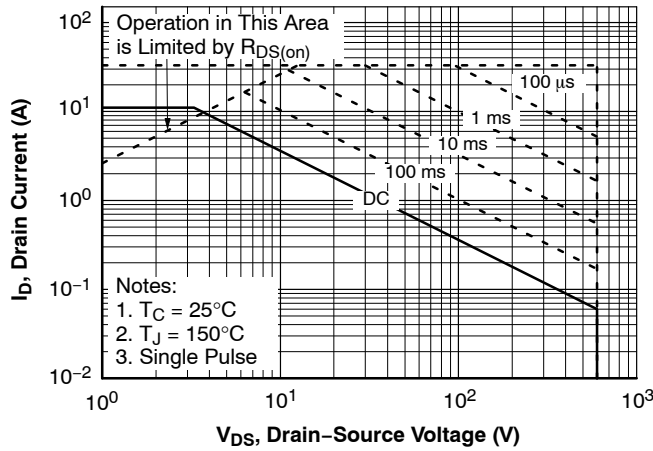


Figure 9. Safe Operating Area

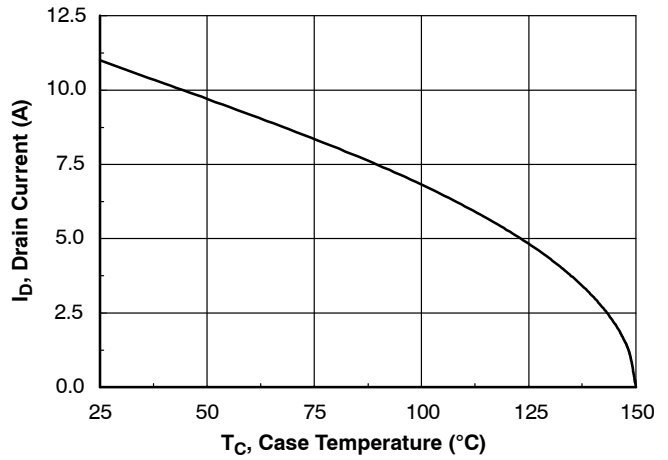


Figure 10. Maximum Drain Current vs. Case Temperature

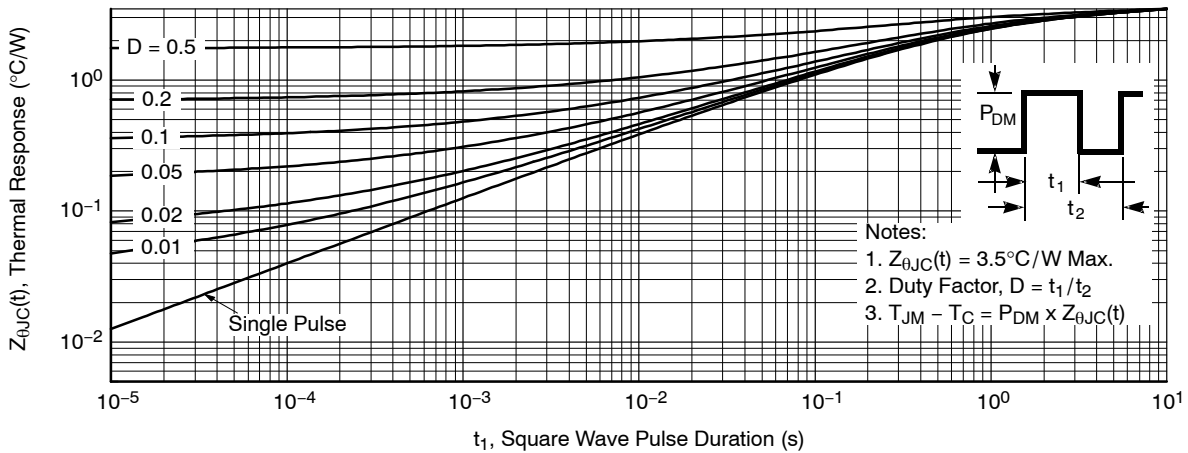


Figure 11. Transient Thermal Response Curve

## FCPF11N60F

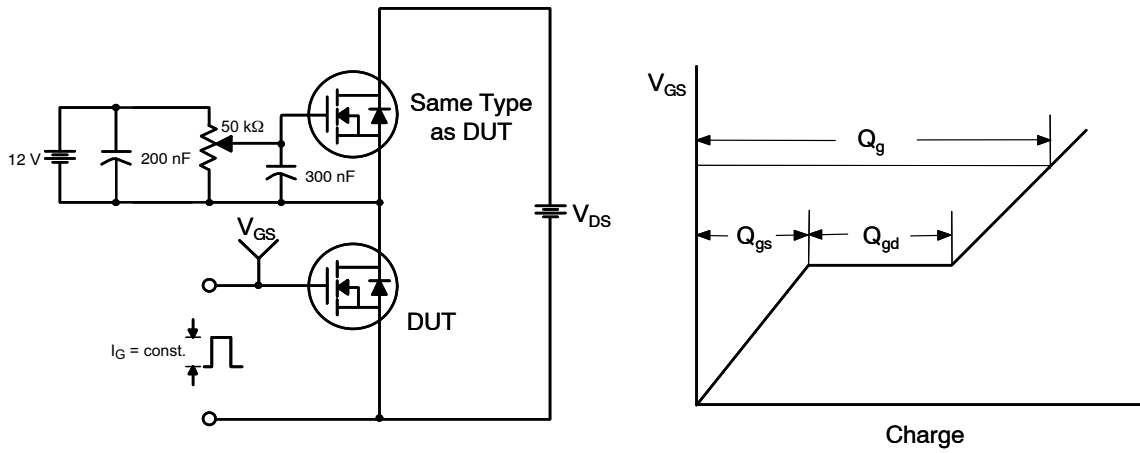


Figure 12. Gate Charge Test Circuit & Waveform

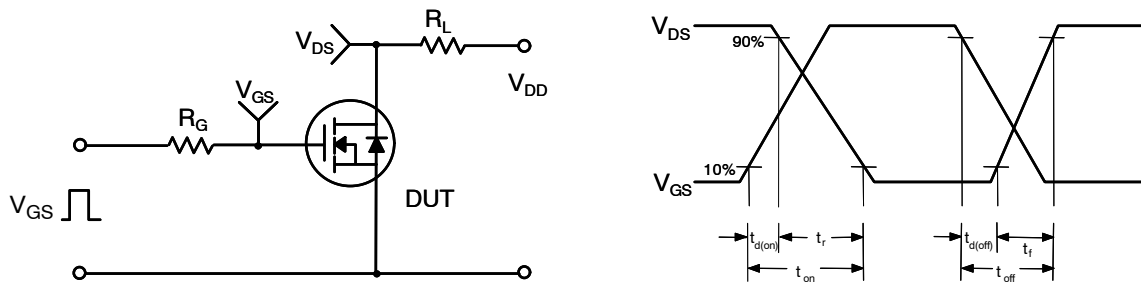


Figure 13. Resistive Switching Test Circuit & Waveforms

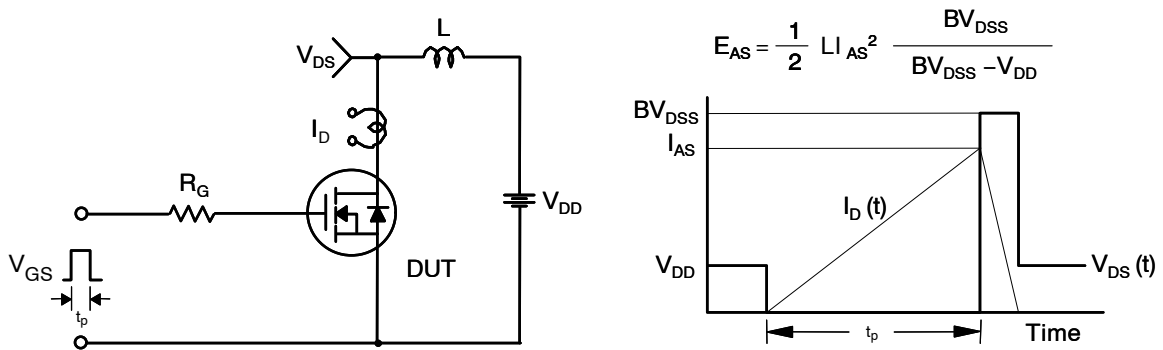


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms

## FCPF11N60F

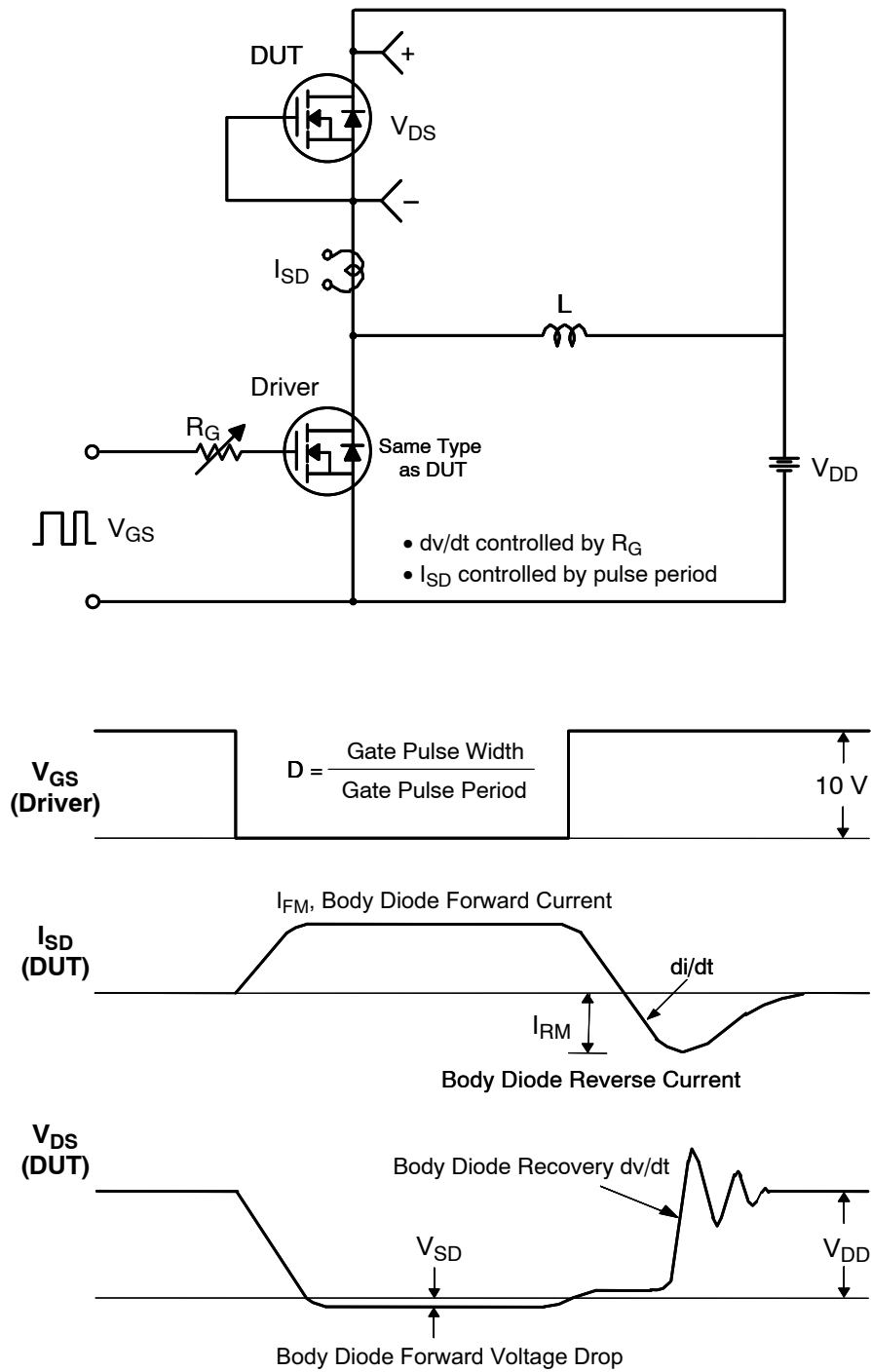
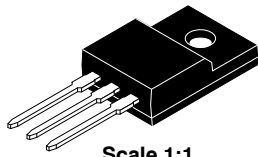


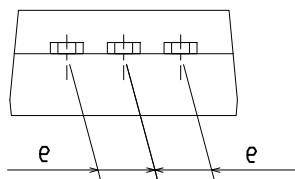
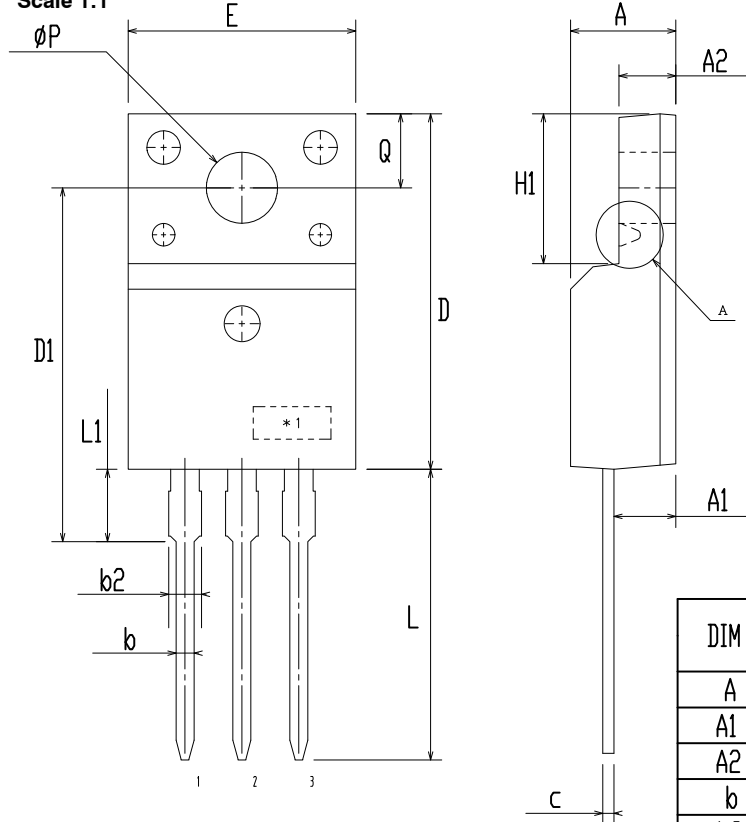
Figure 15. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms

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

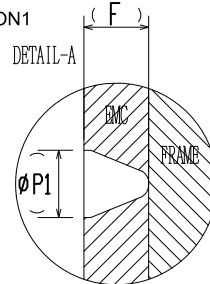
DATE 19 JAN 2021



Scale 1:1



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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