

# MOSFET – N-Channel, QFET, FRFET®

**500 V, 13 A, 540 mΩ**

**FQPF13N50CF**

## Description

This N-Channel enhancement mode power MOSFET is produced using onsemi's proprietary planar stripe and DMOS technology. This advanced MOSFET technology has been especially tailored to reduce on-state resistance, and to provide superior switching performance and high avalanche energy strength. These devices are suitable for switched mode power supplies, active power factor correction (PFC), and electronic lamp ballasts.

## Features

- 13 A, 500 V,  $R_{DS(on)}$  = 540 mΩ (Max) @  $V_{GS}$  = 10 V,  $I_D$  = 6.5 A
- Low Gate Charge (Typ. 43 nC)
- Low  $C_{rss}$  (Typ. 20 pF)
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

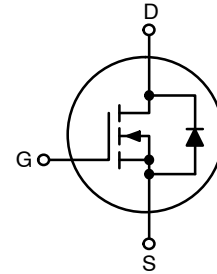
## ABSOLUTE MAXIMUM RATINGS ( $T_C$ = 25°C unless otherwise noted)

| Symbol         | Parameter                                                                     | Value       | Unit |
|----------------|-------------------------------------------------------------------------------|-------------|------|
| $V_{DSS}$      | Drain to Source Voltage                                                       | 500         | V    |
| $I_D$          | Drain Current – Continuous ( $T_C$ = 25°C)                                    | 13          | A    |
|                | – Continuous ( $T_C$ = 100°C)                                                 | 8           | A    |
| $I_{DM}$       | Drain Current – Pulsed (Note 1)                                               | 52          | A    |
| $V_{GSS}$      | Gate-Source Voltage                                                           | ±30         | V    |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                       | 530         | mJ   |
| $I_{AR}$       | Avalanche Current (Note 1)                                                    | 13          | A    |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                          | 19.5        | mJ   |
| $dv/dt$        | Peak Diode Recovery $dv/dt$ (Note 3)                                          | 4.5         | V/ns |
| $P_D$          | Power Dissipation ( $T_C$ = 25°C)                                             | 48          | W    |
|                | – Derate Above 25°C                                                           | 0.39        | W/°C |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                                       | –55 to +150 | °C   |
| $T_L$          | Maximum Lead Temperature for Soldering Purposes, 1/8" from Case for 5 seconds | 300         | °C   |

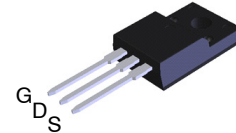
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2.  $L$  = 5.6 mH,  $I_{AS}$  = 13 A,  $V_{DD}$  = 50 V,  $R_G$  = 25 Ω, starting  $T_J$  = 25 °C.
3.  $I_{SD}$  ≤ 13 A,  $di/dt$  ≤ 200 A/μs,  $V_{DD}$  ≤  $BV_{DSS}$ , Starting  $T_J$  = 25 °C.

| $V_{DS}$ | $R_{DS(ON)}$ MAX | $I_D$ MAX |
|----------|------------------|-----------|
| 500 V    | 540 mΩ @ 10 V    | 13 A      |



N-Channel MOSFET



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

## MARKING DIAGRAM



FQPF13N50CF = Device Code  
A = Assembly Location  
YWW = Date Code (Year & Week)  
ZZ = Assembly Lot

## ORDERING INFORMATION

| Device      | Package           | Shipping    |
|-------------|-------------------|-------------|
| FQPF13N50CF | TO-220F (Pb-Free) | 1000 / Tube |

# FQPF13N50CF

## THERMAL CHARACTERISTICS

| Symbol          | Parameter                                     | Value | Unit |
|-----------------|-----------------------------------------------|-------|------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case, Max.    | 2.58  | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient, Max. | 62.5  |      |

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

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

### OFF CHARACTERISTICS

|                                |                                           |                                                             |     |     |      |               |
|--------------------------------|-------------------------------------------|-------------------------------------------------------------|-----|-----|------|---------------|
| $BV_{DSS}$                     | Drain-Source Breakdown Voltage            | $I_D = 250\ \mu\text{A}$ , $V_{GS} = 0\ \text{V}$           | 500 | –   | –    | V             |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$ | –   | 0.5 | –    | V/°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  | $\mu\text{A}$ |
| $I_{GSSF}$                     | Gate-Body Leakage Current, Forward        | $V_{GS} = 30\ \text{V}$ , $V_{DS} = 0\ \text{V}$            | –   | –   | 100  | nA            |
| $I_{GSSR}$                     | Gate-Body Leakage Current, Reverse        | $V_{GS} = -30\ \text{V}$ , $V_{DS} = 0\ \text{V}$           | –   | –   | -100 | nA            |

### ON CHARACTERISTICS

|              |                                   |                                                 |     |      |      |          |
|--------------|-----------------------------------|-------------------------------------------------|-----|------|------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}$ , $I_D = 250\ \mu\text{A}$    | 2.0 | –    | 4.0  | V        |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS} = 10\ \text{V}$ , $I_D = 6.5\ \text{A}$ | –   | 0.43 | 0.54 | $\Omega$ |
| $g_{FS}$     | Forward Transconductance          | $V_{DS} = 40\ \text{V}$ , $I_D = 6.5\ \text{A}$ | –   | 15   | –    | S        |

### DYNAMIC CHARACTERISTICS

|           |                              |                                                                          |   |      |      |    |
|-----------|------------------------------|--------------------------------------------------------------------------|---|------|------|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 25\ \text{V}$ , $V_{GS} = 0\ \text{V}$ , $f = 1.0\ \text{MHz}$ | – | 1580 | 2055 | pF |
| $C_{oss}$ | Output Capacitance           |                                                                          | – | 180  | 235  | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                          | – | 20   | 25   | pF |

### SWITCHING CHARACTERISTICS

|              |                     |                                                                                          |   |      |     |    |
|--------------|---------------------|------------------------------------------------------------------------------------------|---|------|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 250\ \text{V}$ , $I_D = 13\ \text{A}$ ,<br>$R_G = 25\ \Omega$<br>(Note 4)      | – | 25   | 60  | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                          | – | 100  | 210 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                          | – | 130  | 270 | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                          | – | 100  | 210 | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 400\ \text{V}$ , $I_D = 13\ \text{A}$ ,<br>$V_{GS} = 10\ \text{V}$<br>(Note 4) | – | 43   | 56  | nC |
| $Q_{gs}$     | Gate-Source Charge  |                                                                                          | – | 7.5  | –   | nC |
| $Q_{gd}$     | Gate-Drain Charge   |                                                                                          | – | 18.5 | –   | nC |

### DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

|                 |                                                       |                                                                                 |   |      |     |    |
|-----------------|-------------------------------------------------------|---------------------------------------------------------------------------------|---|------|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain–Source Diode Forward Current |                                                                                 | – | –    | 13  | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain–Source Diode Forward Current     |                                                                                 | – | –    | 52  | A  |
| V <sub>SD</sub> | Drain–Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 13A                                     | – | –    | 1.4 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 13 A,<br>dI <sub>F</sub> /dt = 100 A/μs | – | 100  | 160 | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                               |                                                                                 | – | 0.35 | –   | 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

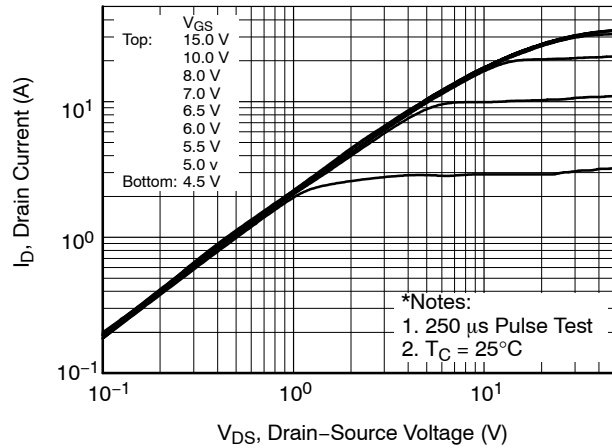


Figure 1. On-Region Characteristics

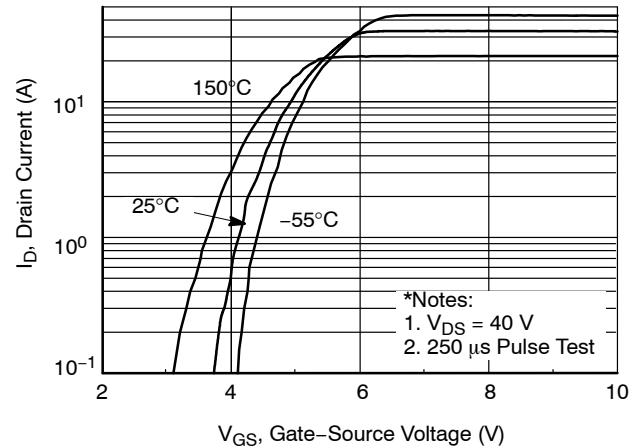


Figure 2. Transfer Characteristics

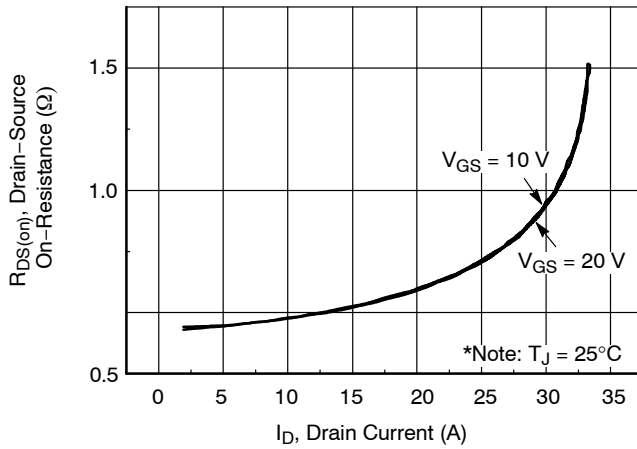


Figure 3. On-Resistance Variation vs Drain Current and Gate Voltage

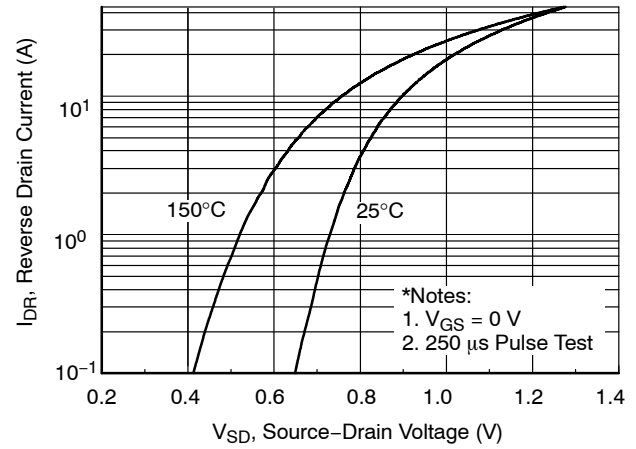


Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature

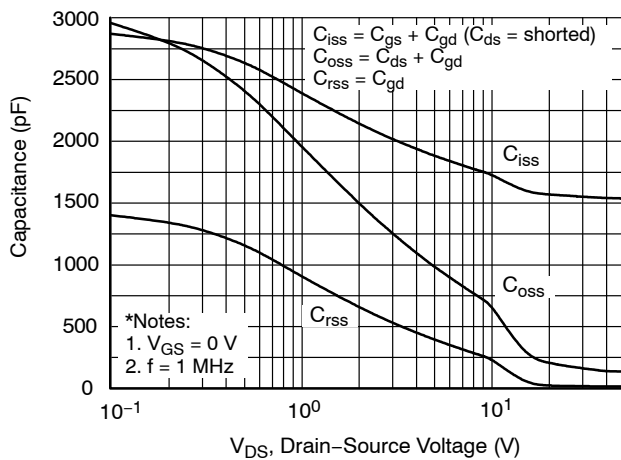


Figure 5. Capacitance Characteristics

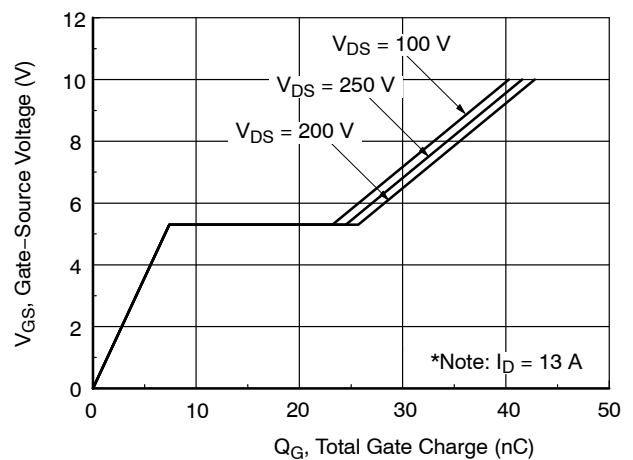
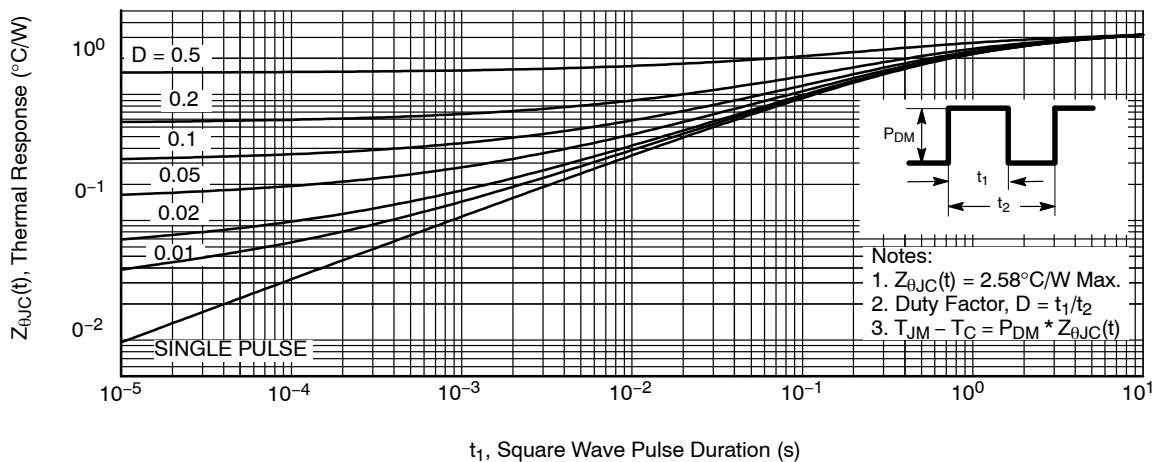
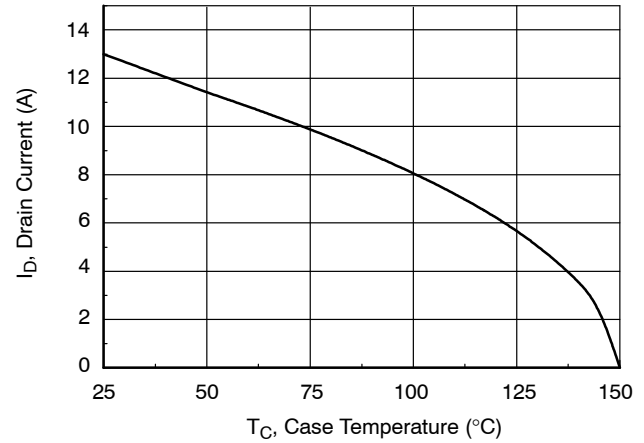
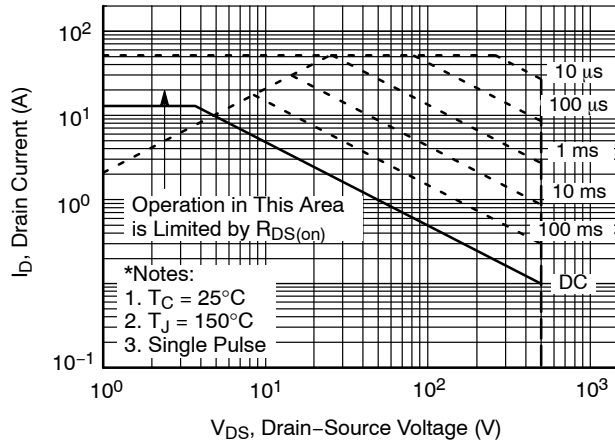
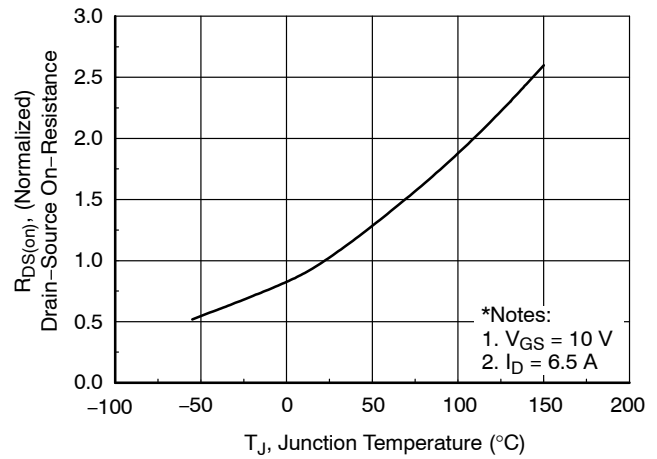
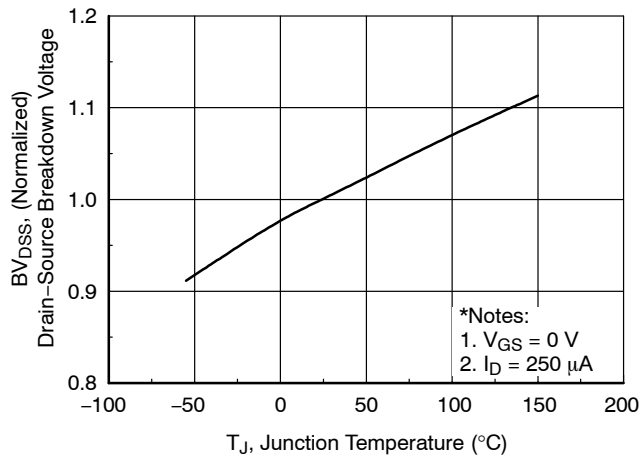
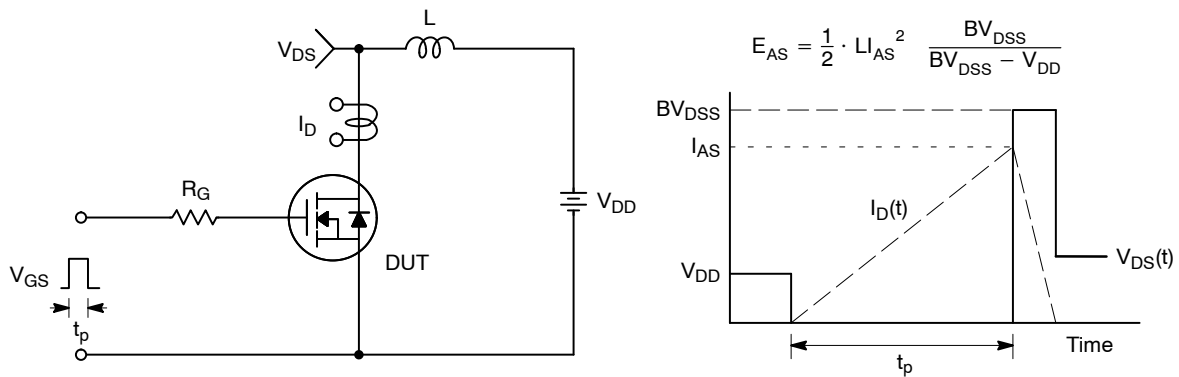
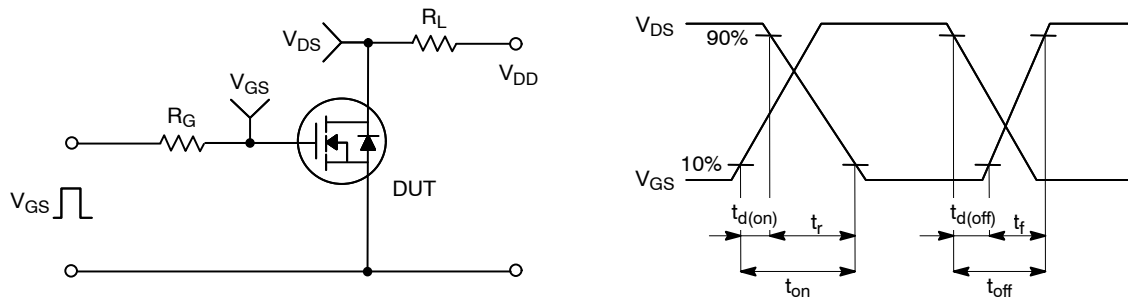
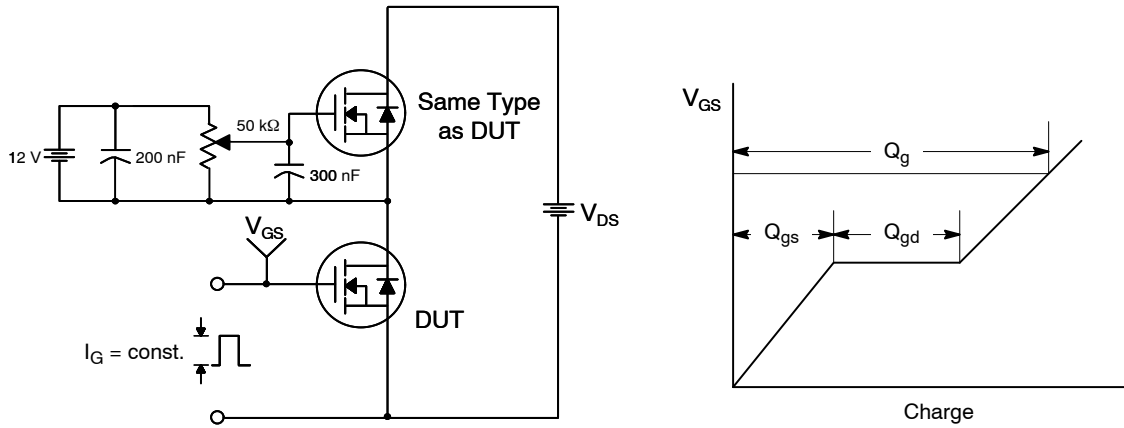


Figure 6. Gate Charge Characteristics

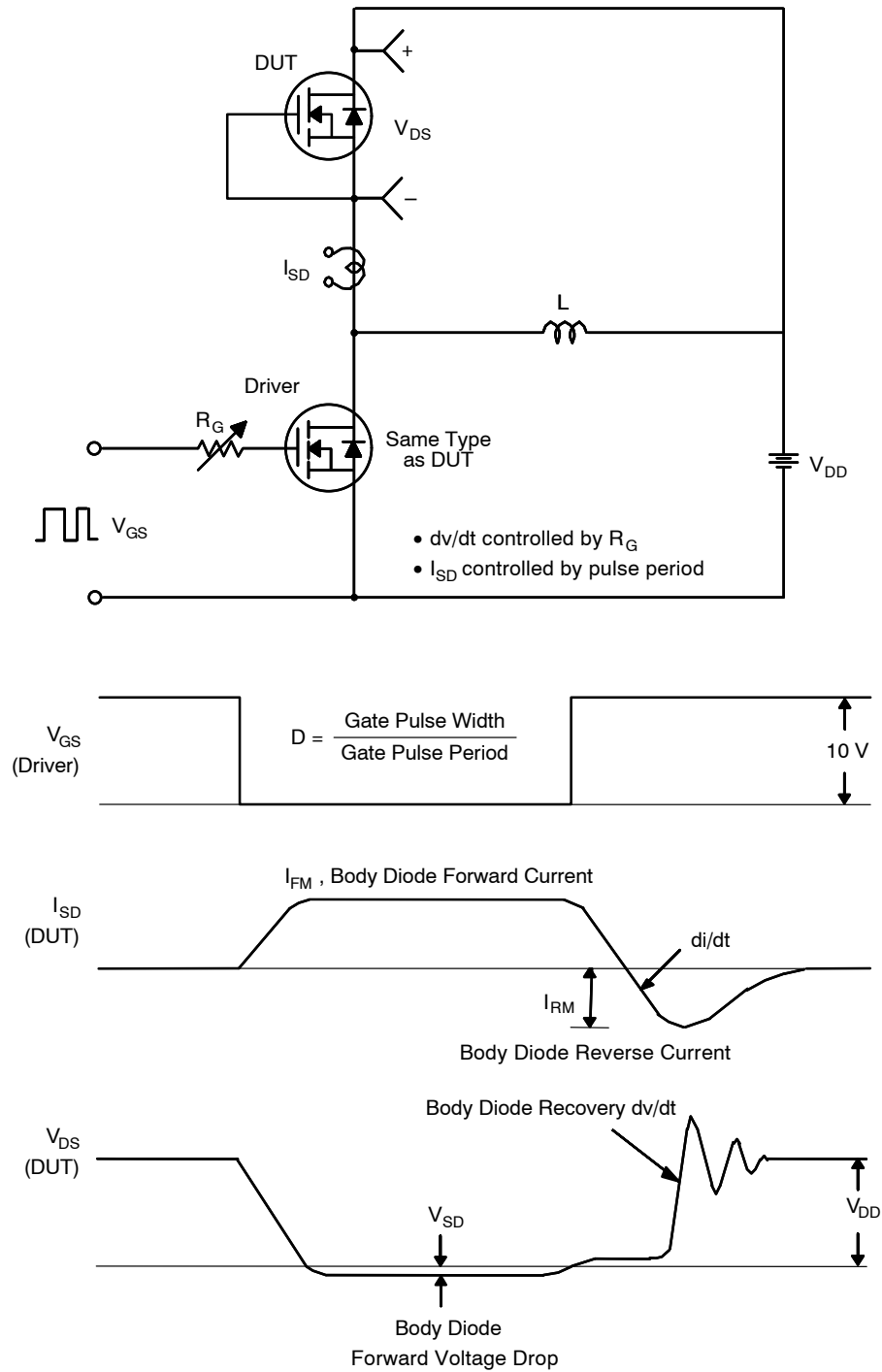
**TYPICAL CHARACTERISTICS (continued)**



# FQPF13N50CF



# FQPF13N50CF



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

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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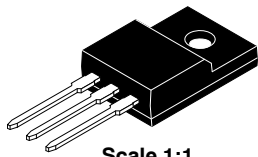
ON

### TO-220 Fullpack, 3-Lead / TO-220F-3SG

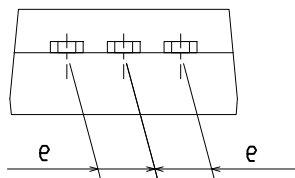
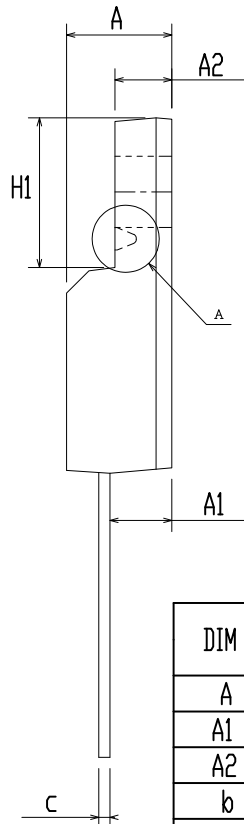
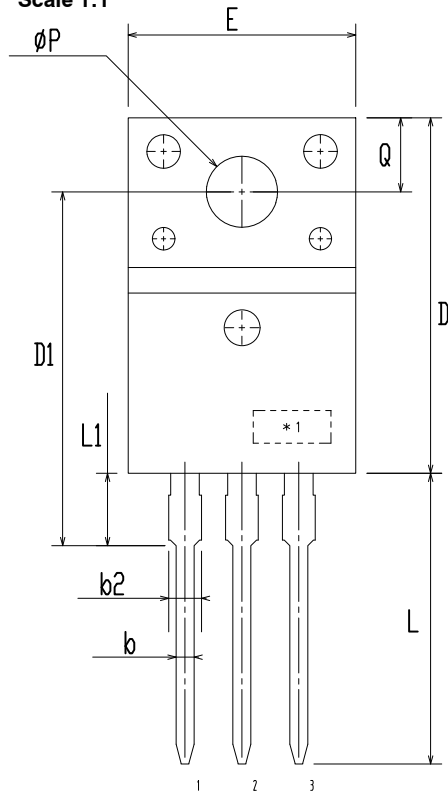
#### CASE 221AT

#### ISSUE B

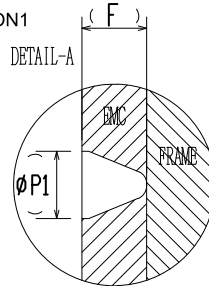
DATE 19 JAN 2021



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:

- DIMENSION AND TOLERANCE AS ASME Y14.5-2009
- DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUCTIONS.
- 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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