

# MOSFET – Power, N-Channel, SUPERFET® III, Easy Drive

**650 V, 24 A, 125 mΩ**

## FCPF125N65S3

### Description

SUPERFET III 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 advanced technology is tailored to minimize conduction loss, provides superior switching performance, and withstand extreme dv/dt rate.

Consequently, SUPERFET III MOSFET Easy drive series helps manage EMI issues and allows for easier design implementation.

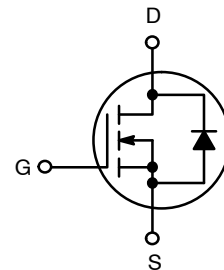
### Features

- 700 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 105\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 44\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 405\text{ pF}$ )
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

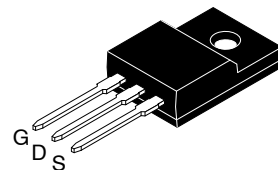
### Applications

- Computing / Display Power Supplies
- Telecom / Server Power Supplies
- Industrial Power Supplies
- Lighting / Charger / Adapter

| $V_{DSS}$ | $R_{DS(on)}\text{ MAX}$ | $I_D\text{ MAX}$ |
|-----------|-------------------------|------------------|
| 650 V     | 125 mΩ @ 10 V           | 24 A             |

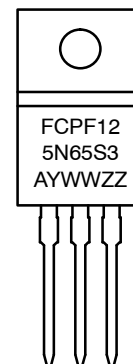


**POWER MOSFET**



**TO-220 Fullpack  
CASE 221AT**

### MARKING DIAGRAM



|              |                           |
|--------------|---------------------------|
| FCPF125N65S3 | = Specific Device Code    |
| A            | = Assembly Location       |
| YWW          | = Date Code (Year & Week) |
| ZZ           | = Assembly Lot            |

### ORDERING INFORMATION

| Device       | Package         | Shipping          |
|--------------|-----------------|-------------------|
| FCPF125N65S3 | TO-220 Fullpack | 1000 Units / Tube |

# FCPF125N65S3

## ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ , Unless otherwise noted)

| Symbol         | Parameter  |  | Value       | Unit                |
|----------------|--|--|-------------|---------------------|
| $V_{DSS}$      | Drain to Source Voltage  |  | 650         | V                   |
| $V_{GSS}$      | Gate to Source Voltage   | – DC                                       | $\pm 30$    | V                   |
|                |  | – AC ( $f > 1\text{ Hz}$ )                 | $\pm 30$    |                     |
| $I_D$          | Drain Current  | – Continuous ( $T_C = 25^\circ\text{C}$ )  | 24*         | A                   |
|                |  | – Continuous ( $T_C = 100^\circ\text{C}$ ) | 15*         |                     |
| $I_{DM}$       | Drain Current  | – Pulsed (Note 1)                          | 60*         | A                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                              |  | 115         | mJ                  |
| $I_{AS}$       | Avalanche Current (Note 2)   |  | 3.7         | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                 |  | 0.38        | mJ                  |
| dv/dt          | MOSFET dv/dt   |  | 100         | V/ns                |
|                | Peak Diode Recovery dv/dt (Note 3)                                   |  | 20          |                     |
| $P_D$          | Power Dissipation  | ( $T_C = 25^\circ\text{C}$ )               | 38          | W                   |
|                |  | – Derate Above $25^\circ\text{C}$          | 0.31        | 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, 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.  $I_{AS} = 3.7\text{ A}$ ,  $R_G = 25\ \Omega$ , starting  $T_J = 25^\circ\text{C}$ .

3.  $I_{SD} \leq 12\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq 400\text{ V}$ , starting  $T_J = 25^\circ\text{C}$ .

## THERMAL CHARACTERISTICS

| Symbol          | Parameter                                     | Value | Unit                      |
|-----------------|---|-------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 3.24  | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 62.5  |                           |

# FCPF125N65S3

## 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> = 1 mA, T <sub>J</sub> = 25°C  | 650 |      |      | V    |
|                                      |   | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA, T <sub>J</sub> = 150°C | 700 |      |      | V    |
| ΔBV <sub>DSS</sub> / ΔT <sub>J</sub> | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 1 mA, Referenced to 25°C                            |     | 0.65 |      | V/°C |
| I <sub>DSS</sub>                     | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V                       |     |      | 1    | μA   |
|                                      |   | V <sub>DS</sub> = 520 V, T <sub>C</sub> = 125°C                      |     | 1.35 |      |      |
| I <sub>GSS</sub>                     | Gate to Body Leakage Current              | V <sub>GS</sub> = ±30 V, V <sub>DS</sub> = 0 V                       |     |      | ±100 | nA   |

### ON CHARACTERISTICS

|                     |                                      |  |     |     |     |    |
|---------------------|--------------------------------------|--|-----|-----|-----|----|
| V <sub>GS(th)</sub> | Gate Threshold Voltage               | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 0.54 mA | 2.5 |     | 4.5 | V  |
| R <sub>DS(on)</sub> | Static Drain to Source On Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 12 A                |     | 105 | 125 | mΩ |
| g <sub>FS</sub>     | Forward Transconductance             | V <sub>DS</sub> = 20 V, I <sub>D</sub> = 12 A                |     | 16  |     | S  |

### DYNAMIC CHARACTERISTICS

|                        |                                   |  |  |      |  |    |
|------------------------|-----------------------------------|--|--|------|--|----|
| C <sub>iss</sub>       | Input Capacitance                 | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 1 MHz                          |  | 1790 |  | pF |
| C <sub>oss</sub>       | Output Capacitance                |  |  | 40   |  | pF |
| C <sub>oss(eff.)</sub> | Effective Output Capacitance      | V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V                              |  | 405  |  | pF |
| C <sub>oss(er.)</sub>  | Energy Related Output Capacitance | V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V                              |  | 60   |  | pF |
| Q <sub>g(tot)</sub>    | Total Gate Charge at 10 V         | V <sub>DS</sub> = 400 V, I <sub>D</sub> = 12 A, V <sub>GS</sub> = 10 V<br>(Note 4) |  | 44   |  | nC |
| Q <sub>gs</sub>        | Gate to Source Gate Charge        |  |  | 12   |  | nC |
| Q <sub>gd</sub>        | Gate to Drain "Miller" Charge     |  |  | 19   |  | nC |
| ESR                    | Equivalent Series Resistance      | f = 1 MHz  |  | 4    |  | Ω  |

### SWITCHING CHARACTERISTICS

|                     |                     |   |  |    |  |    |
|---------------------|---------------------|---|--|----|--|----|
| t <sub>d(on)</sub>  | Turn-On Delay Time  | V <sub>DD</sub> = 400 V, I <sub>D</sub> = 12 A, V <sub>GS</sub> = 10 V,<br>R <sub>g</sub> = 4.7 Ω<br>(Note 4) |  | 22 |  | ns |
| t <sub>r</sub>      | Turn-On Rise Time   |   |  | 25 |  | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time |   |  | 60 |  | ns |
| t <sub>f</sub>      | Turn-Off Fall Time  |   |  | 15 |  | ns |

### SOURCE-DRAIN DIODE CHARACTERISTICS

|                 |  |  |  |      |    |
|-----------------|--|--|--|------|----|
| I <sub>S</sub>  | Maximum Continuous Source to Drain Diode Forward Current |  |  | 24   | A  |
| I <sub>SM</sub> | Maximum Pulsed Source to Drain Diode Forward Current     |  |  | 60   | A  |
| V <sub>SD</sub> | Source to Drain Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 12 A                                      |  | 1.2  | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>DD</sub> = 400 V, I <sub>SD</sub> = 12 A,<br>dI <sub>F</sub> /dt = 100 A/μs |  | 362  | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  |  |  | 6.36 | 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.

## TYPICAL PERFORMANCE CHARACTERISTICS

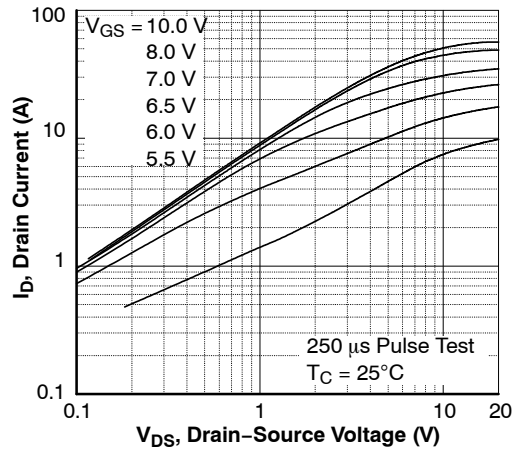


Figure 1. On-Region Characteristics

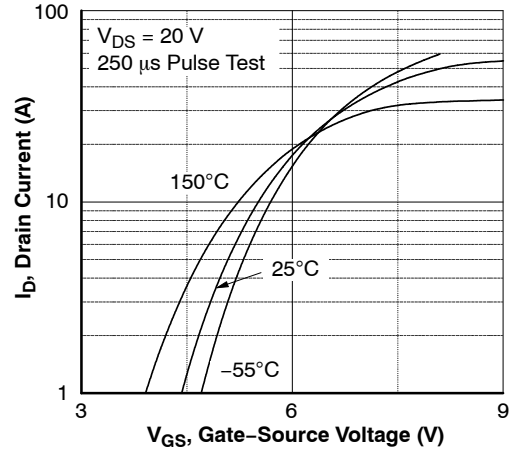


Figure 2. Transfer Characteristics

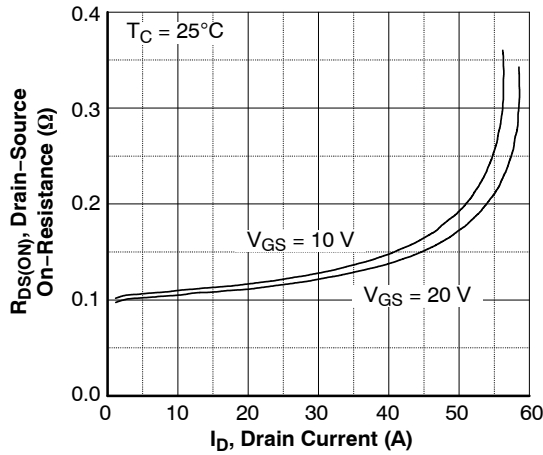


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

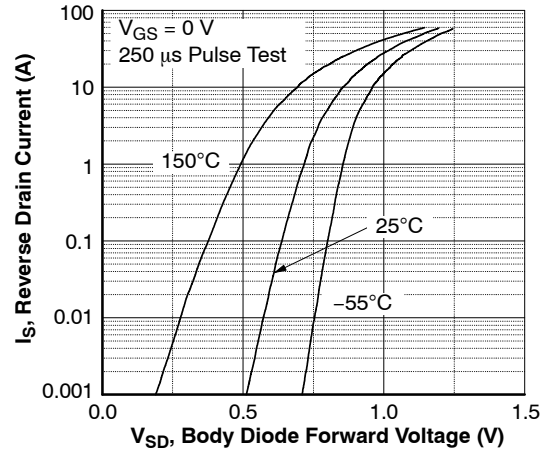


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

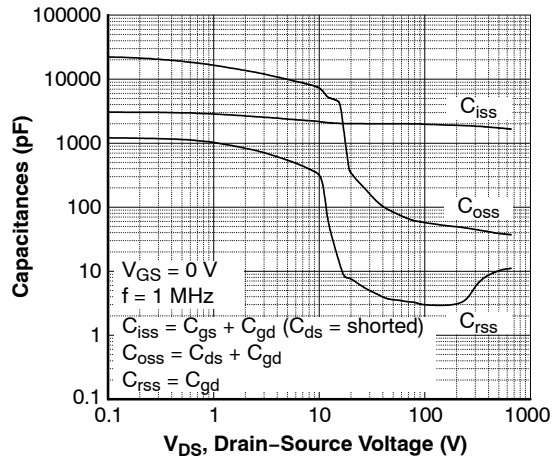


Figure 5. Capacitance Characteristics

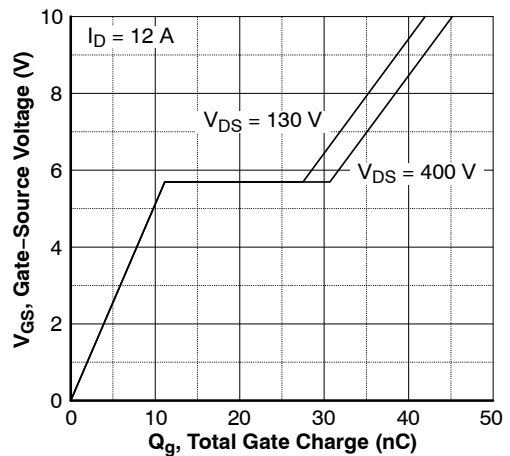


Figure 6. Gate Charge Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

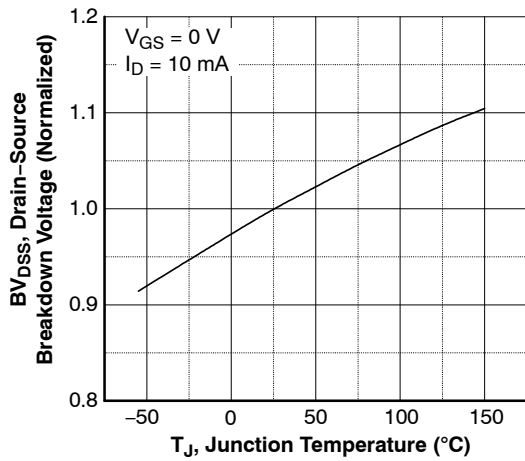


Figure 7. Breakdown Voltage Variation vs. Temperature

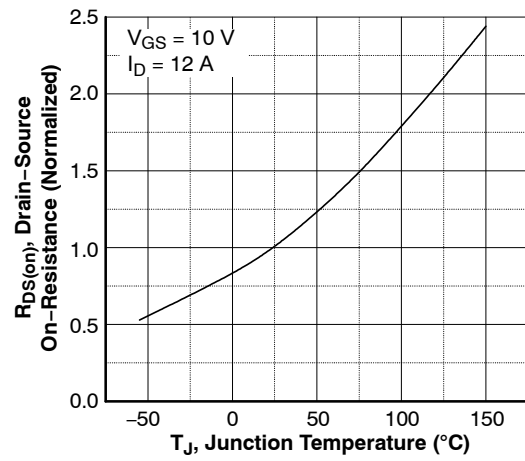


Figure 8. On-Resistance Variation vs. Temperature

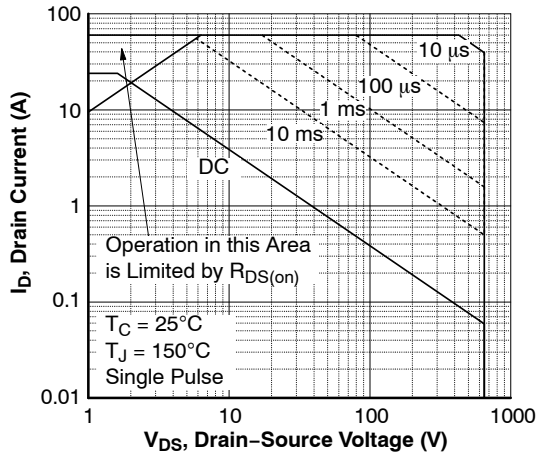


Figure 9. Maximum Safe Operating Area

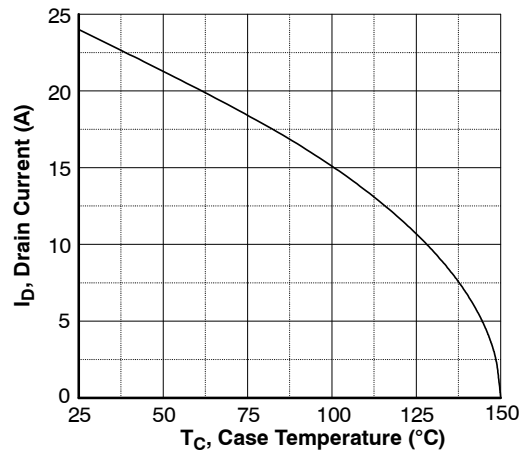


Figure 10. Maximum Drain Current vs. Case Temperature

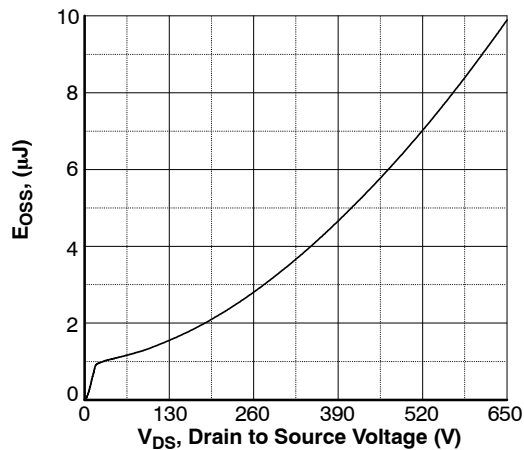


Figure 11.  $E_{OSS}$  vs. Drain to Source Voltage

## TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

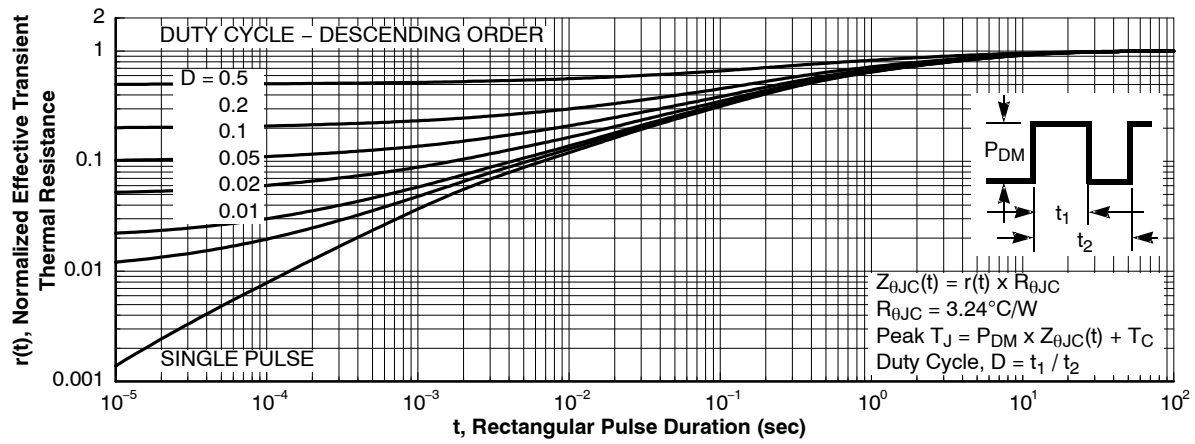


Figure 12. Transient Thermal Response Curve

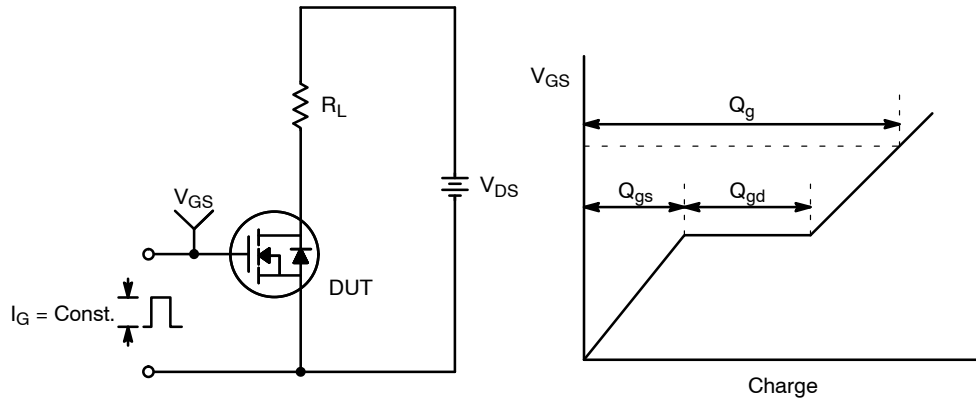


Figure 13. Gate Charge Test Circuit & Waveform



Figure 14. Resistive Switching Test Circuit & Waveforms



Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

# FCPF125N65S3



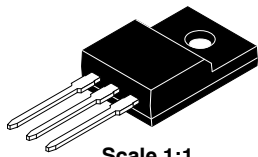
**Figure 16. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**



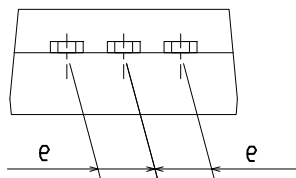
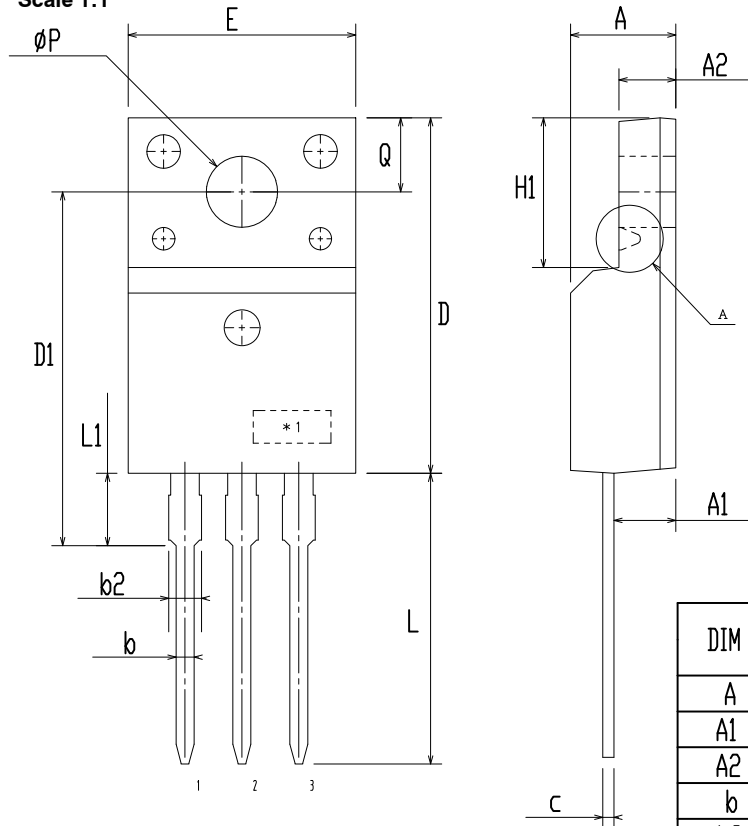
### TO-220 Fullpack, 3-Lead / TO-220F-3SG

CASE 221AT  
ISSUE B

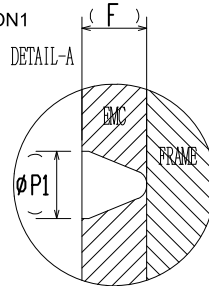
DATE 19 JAN 2021



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:

- 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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