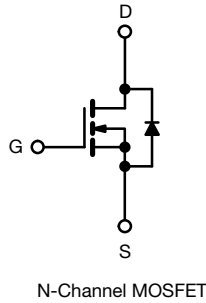
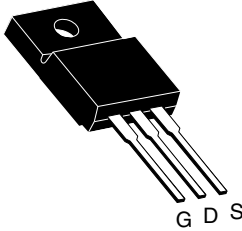


## D Series Power MOSFET

**TO-220 FULLPAK**


### FEATURES

- Optimal design
  - Low area specific on-resistance
  - Low input capacitance ( $C_{iss}$ )
  - Reduced capacitive switching losses
  - High body diode ruggedness
  - Avalanche energy rated (UIS)
- Optimal efficiency and operation
  - Low cost
  - Simple gate drive circuitry
  - Low figure-of-merit (FOM):  $R_{on} \times Q_g$
  - Fast switching
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

### PRODUCT SUMMARY

|   |                 |     |
|---|-----------------|-----|
| $V_{DS}$ (V) at $T_J$ max.              | 550             |     |
| $R_{DS(on)}$ max. ( $\Omega$ ) at 25 °C | $V_{GS} = 10$ V | 1.5 |
| $Q_g$ max. (nC)                         | 20              |     |
| $Q_{gs}$ (nC)                           | 3               |     |
| $Q_{gd}$ (nC)                           | 5               |     |
| Configuration                           | Single          |     |

### APPLICATIONS

- Consumer electronics
  - Displays (LCD or plasma TV)
- Server and telecom power supplies
  - SMPS
- Industrial
  - Welding
  - Induction heating
  - Motor drives
- Battery chargers

### ORDERING INFORMATION

|                |                |
|----------------|----------------|
| Package        | TO-220 FULLPAK |
| Lead (Pb)-free | SiHF5N50D-E3   |

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


| PARAMETER   | SYMBOL           | LIMIT          | UNIT |
|---|------------------|----------------|------|
| Drain-Source Voltage                                      | $V_{DS}$         | 500            | V    |
| Gate-Source Voltage                                       | $V_{GS}$         | $\pm 30$       |      |
| Gate-Source Voltage AC ( $f > 1$ Hz)                      |                  | 30             |      |
| Continuous Drain Current ( $T_J = 150$ °C) <sup>e</sup>   | $V_{GS}$ at 10 V | $T_C = 25$ °C  | A    |
|   |                  | $T_C = 100$ °C |      |
| Pulsed Drain Current <sup>a</sup>                         | $I_{DM}$         | 10             |      |
| Linear Derating Factor                                    |                  | 0.24           | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>                | $E_{AS}$         | 23             | mJ   |
| Maximum Power Dissipation                                 | $P_D$            | 28.8           | W    |
| Operating Junction and Storage Temperature Range          | $T_J, T_{stg}$   | -55 to +150    | °C   |
| Drain-Source Voltage Slope                                | $dV/dt$          | $T_J = 125$ °C | 24   |
| Reverse Diode $dV/dt$ <sup>d</sup>                        |                  | 0.28           |      |
| Soldering Recommendations (Peak temperature) <sup>c</sup> | For 10 s         | 300            | °C   |
| Mounting Torque   | M3 screw         | 0.6            | Nm   |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 2.3$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 5$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ , starting  $T_J = 25$  °C.
- Limited by maximum junction temperature.



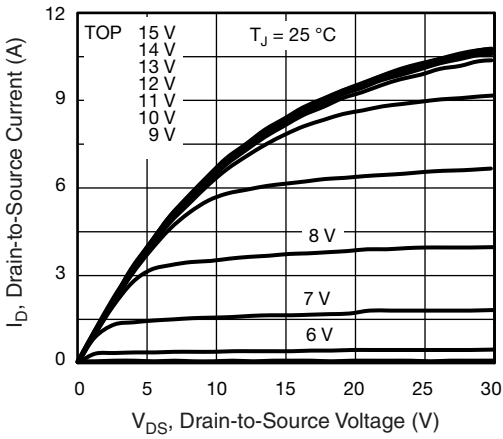
| THERMAL RESISTANCE RATINGS       |            |      |      |      |
|----------------------------------|------------|------|------|------|
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 65   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 4.1  |      |

| SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                     |   |   |   |      |           |               |    |   |
|---|---------------------|---|---|---|------|-----------|---------------|----|---|
| PARAMETER   | SYMBOL              | TEST CONDITIONS   |   | MIN.  | TYP. | MAX.      | UNIT          |    |   |
| <b>Static</b>   |                     |   |   |   |      |           |               |    |   |
| Drain-Source Breakdown Voltage  | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$   |   | 500   | -    | -         | V             |    |   |
| $V_{DS}$ Temperature Coefficient  | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}, I_D = 250\text{ }\mu\text{A}$   |   | -   | 0.58 | -         | V/°C          |    |   |
| Gate-Source Threshold Voltage (N)   | $V_{GS(th)}$        | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$   |   | 3   | -    | 5         | V             |    |   |
| Gate-Source Leakage   | $I_{GSS}$           | $V_{GS} = \pm 30\text{ V}$  |   | -   | -    | $\pm 100$ | nA            |    |   |
| Zero Gate Voltage Drain Current   | $I_{DSS}$           | $V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}$  |   | -   | -    | 1         | $\mu\text{A}$ |    |   |
|   |                     | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$   |   | -   | -    | 10        |               |    |   |
| Drain-Source On-State Resistance  | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$  | $I_D = 2.5\text{ A}$                        | -   | 1.2  | 1.5       | $\Omega$      |    |   |
| Forward Transconductance <sup>a</sup>                                       | $g_{fs}$            | $V_{DS} = 20\text{ V}, I_D = 2.5\text{ A}$  |   | -   | 1.8  | -         | S             |    |   |
| <b>Dynamic</b>  |                     |   |   |   |      |           |               |    |   |
| Input Capacitance   | $C_{iss}$           | $V_{GS} = 0\text{ V}, V_{DS} = 100\text{ V}, f = 1\text{ MHz}$  |   | -   | 325  | -         | pF            |    |   |
| Output Capacitance  | $C_{oss}$           |   |   | -   | 34   | -         |               |    |   |
| Reverse Transfer Capacitance  | $C_{rss}$           |   |   | -   | 6    | -         |               |    |   |
| Effective Output Capacitance, Energy Related <sup>b</sup>                   | $C_{o(er)}$         |   |   | $V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$ |      | -         |               | 31 | - |
| Effective Output Capacitance, Time Related <sup>c</sup>                     | $C_{o(tr)}$         |   |   |   |      | -         |               | 41 | - |
| Total Gate Charge   | $Q_g$               | $V_{GS} = 10\text{ V}$  | $I_D = 2.5\text{ A}, V_{DS} = 400\text{ V}$ | -   | 10   | 20        | nC            |    |   |
| Gate-Source Charge  | $Q_{gs}$            |   |   | -   | 3    | -         |               |    |   |
| Gate-Drain Charge   | $Q_{gd}$            |   |   | -   | 5    | -         |               |    |   |
| Turn-On Delay Time  | $t_{d(on)}$         | $V_{DD} = 400\text{ V}, I_D = 2.5\text{ A}, R_g = 9.1\text{ }\Omega, V_{GS} = 10\text{ V}$  |   | -   | 12   | 24        | ns            |    |   |
| Rise Time   | $t_r$               |   |   | -   | 11   | 22        |               |    |   |
| Turn-Off Delay Time   | $t_{d(off)}$        |   |   | -   | 14   | 28        |               |    |   |
| Fall Time   | $t_f$               |   |   | -   | 11   | 22        |               |    |   |
| Gate Input Resistance   | $R_g$               | $f = 1\text{ MHz}, \text{open drain}$   |   | -   | 1.7  | -         | $\Omega$      |    |   |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |   |   |   |      |           |               |    |   |
| Continuous Source-Drain Diode Current                                       | $I_S$               | MOSFET symbol showing the integral reverse P - N junction diode  |   | -   | -    | 5         | A             |    |   |
| Pulsed Diode Forward Current  | $I_{SM}$            |   |   | -   | -    | 20        |               |    |   |
| Diode Forward Voltage   | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = 4\text{ A}, V_{GS} = 0\text{ V}$   |   | -   | -    | 1.2       | V             |    |   |
| Reverse Recovery Time   | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = I_S = 2.5\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, V_R = 20\text{ V}$                                       |   | -   | 320  | -         | ns            |    |   |
| Reverse Recovery Charge   | $Q_{rr}$            |   |   | -   | 1.2  | -         | $\mu\text{C}$ |    |   |
| Reverse Recovery Current  | $I_{RRM}$           |   |   | -   | 8    | -         | A             |    |   |

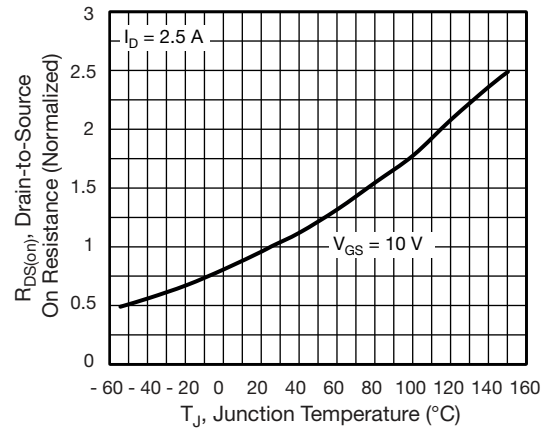
**Note**

- a. Repetitive rating; pulse width limited by maximum junction temperature.
- b.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .
- c.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .

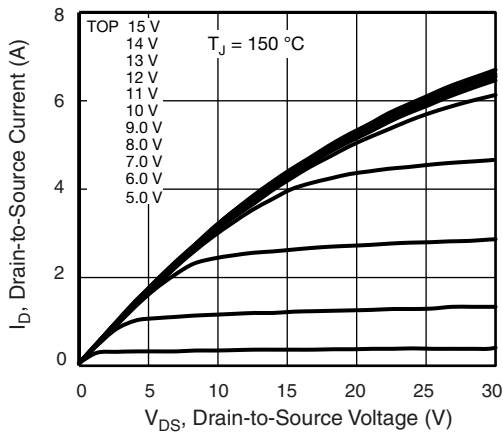
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



**Fig. 1 - Typical Output Characteristics**



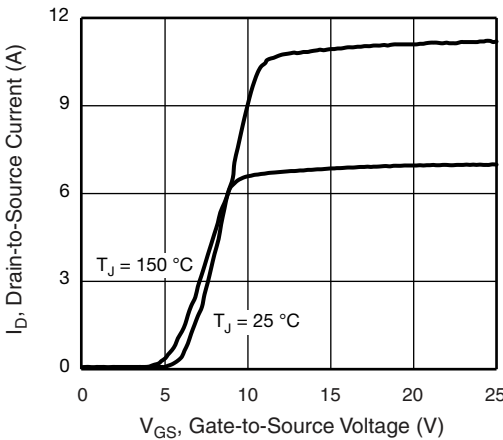
**Fig. 4 - Normalized On-Resistance vs. Temperature**



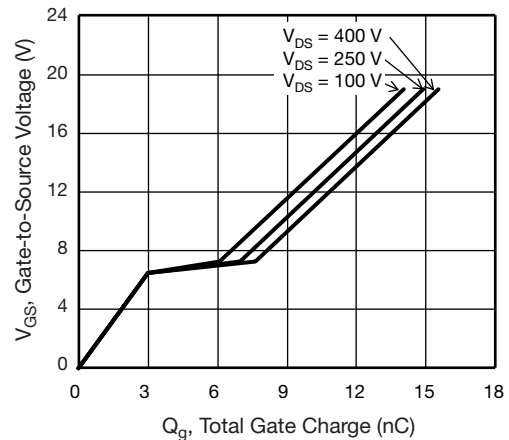
**Fig. 2 - Typical Output Characteristics**



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**



Fig. 7 - Typical Source-Drain Diode Forward Voltage

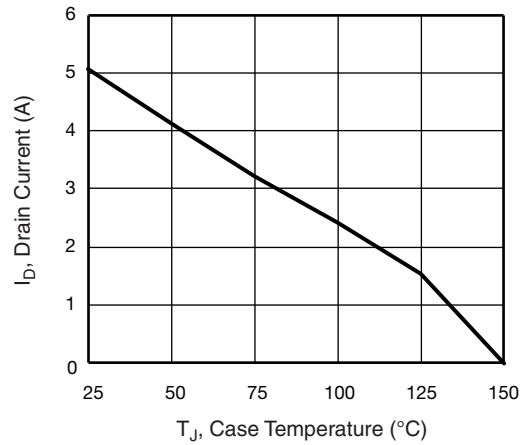


Fig. 9 - Maximum Drain Current vs. Case Temperature

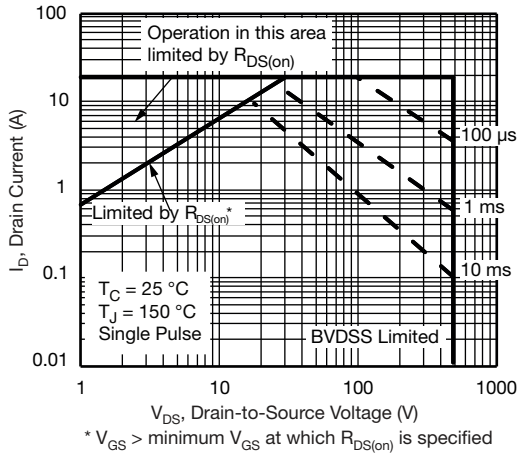


Fig. 8 - Maximum Safe Operating Area



Fig. 10 - Typical Drain-to-Source Voltage vs. Temperature

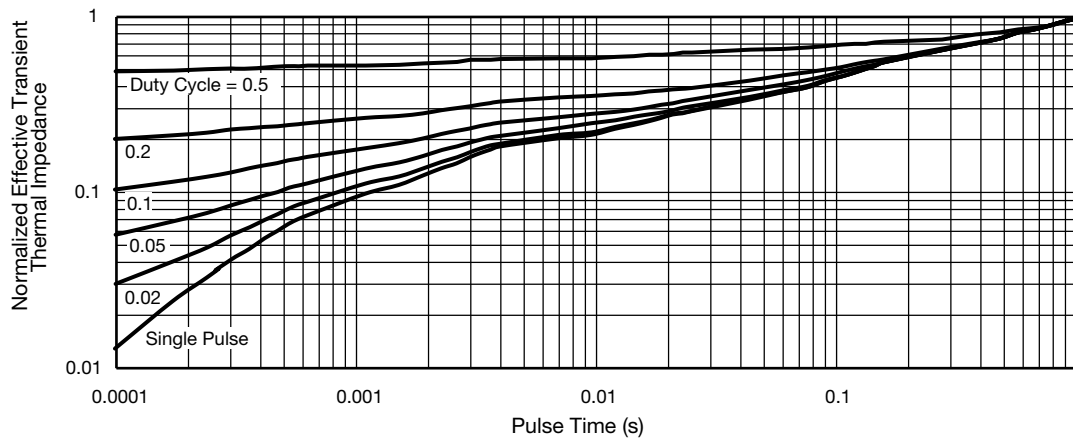


Fig. 11 - Normalized Thermal Transient Impedance, Junction-to-Case



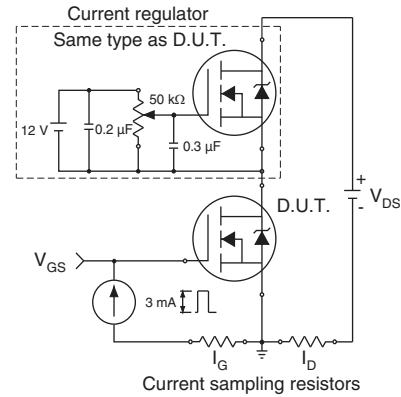
**Fig. 12 - Switching Time Test Circuit**



**Fig. 16 - Basic Gate Charge Waveform**



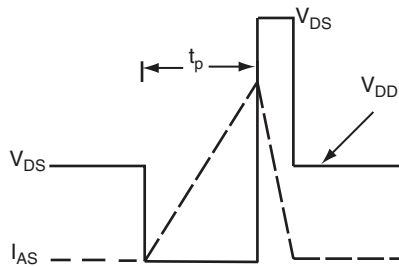
**Fig. 13 - Switching Time Waveforms**



**Fig. 17 - Gate Charge Test Circuit**

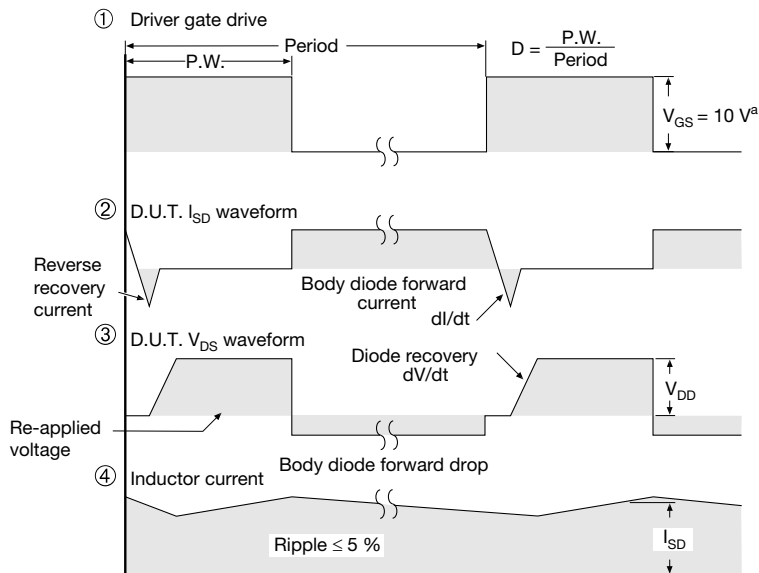
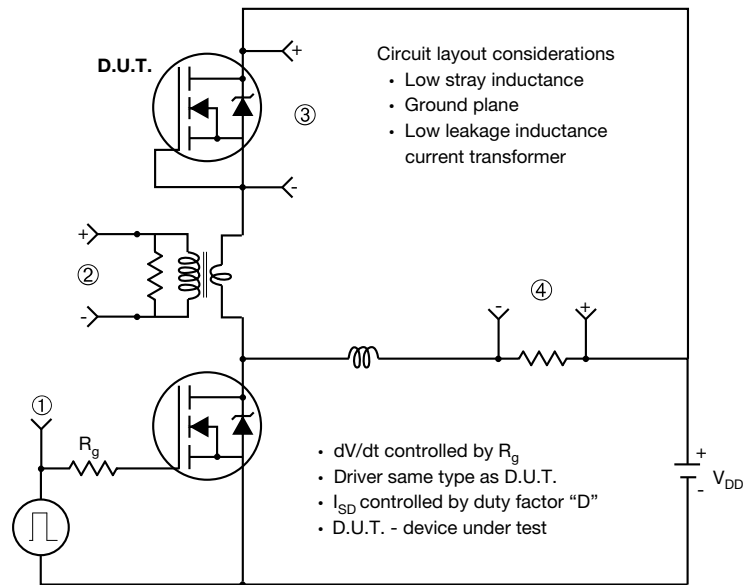


**Fig. 14 - Unclamped Inductive Test Circuit**



**Fig. 15 - Unclamped Inductive Waveforms**

Peak Diode Recovery dV/dt Test Circuit



Note

a.  $V_{GS} = 5\text{ V}$  for logic level devices

Fig. 18 - For N-Channel

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# TO-220 FULLPAK (High Voltage)

## OPTION 1: FACILITY CODE = 9



| DIM.            | MILLIMETERS |       |       |
|-----------------|-------------|-------|-------|
|                 | MIN.        | NOM.  | MAX.  |
| A               | 4.60        | 4.70  | 4.80  |
| b               | 0.70        | 0.80  | 0.91  |
| b1              | 1.20        | 1.30  | 1.47  |
| b2              | 1.10        | 1.20  | 1.30  |
| C               | 0.45        | 0.50  | 0.63  |
| D               | 15.80       | 15.87 | 15.97 |
| e               | 2.54 BSC    |       |       |
| E               | 10.00       | 10.10 | 10.30 |
| F               | 2.44        | 2.54  | 2.64  |
| G               | 6.50        | 6.70  | 6.90  |
| L               | 12.90       | 13.10 | 13.30 |
| L1              | 3.13        | 3.23  | 3.33  |
| Q               | 2.65        | 2.75  | 2.85  |
| Q1              | 3.20        | 3.30  | 3.40  |
| $\varnothing R$ | 3.08        | 3.18  | 3.28  |

### Notes

1. To be used only for process drawing
2. These dimensions apply to all TO-220 FULLPAK leadframe versions 3 leads
3. All critical dimensions should C meet  $C_{pk} > 1.33$
4. All dimensions include burrs and plating thickness
5. No chipping or package damage
6. Facility code will be the 1<sup>st</sup> character located at the 2<sup>nd</sup> row of the unit marking



OPTION 2: FACILITY CODE = Y



| DIM. | MILLIMETERS |        | INCHES    |       |
|------|-------------|--------|-----------|-------|
|      | MIN.        | MAX.   | MIN.      | MAX.  |
| A    | 4.570       | 4.830  | 0.180     | 0.190 |
| A1   | 2.570       | 2.830  | 0.101     | 0.111 |
| A2   | 2.510       | 2.850  | 0.099     | 0.112 |
| b    | 0.622       | 0.890  | 0.024     | 0.035 |
| b2   | 1.229       | 1.400  | 0.048     | 0.055 |
| b3   | 1.229       | 1.400  | 0.048     | 0.055 |
| c    | 0.440       | 0.629  | 0.017     | 0.025 |
| D    | 8.650       | 9.800  | 0.341     | 0.386 |
| d1   | 15.88       | 16.120 | 0.622     | 0.635 |
| d3   | 12.300      | 12.920 | 0.484     | 0.509 |
| E    | 10.360      | 10.630 | 0.408     | 0.419 |
| e    | 2.54 BSC    |        | 0.100 BSC |       |
| L    | 13.200      | 13.730 | 0.520     | 0.541 |
| L1   | 3.100       | 3.500  | 0.122     | 0.138 |
| n    | 6.050       | 6.150  | 0.238     | 0.242 |
| Ø P  | 3.050       | 3.450  | 0.120     | 0.136 |
| u    | 2.400       | 2.500  | 0.094     | 0.098 |
| V    | 0.400       | 0.500  | 0.016     | 0.020 |

ECN: E19-0180-Rev. D, 08-Apr-2019  
DWG: 5972

Notes

1. To be used only for process drawing
2. These dimensions apply to all TO-220 FULLPAK leadframe versions 3 leads
3. All critical dimensions should C meet  $C_{pk} > 1.33$
4. All dimensions include burrs and plating thickness
5. No chipping or package damage
6. Facility code will be the 1<sup>st</sup> character located at the 2<sup>nd</sup> row of the unit marking





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