

FCPF20N60T-VB Datasheet

N-Channel 650 V (D-S) Super Junction Power MOSFET

| PRODUCT SUMMARY | | |
|------------------------------------|-----------------|------|
| V_{DS} (V) at T_J max. | 650 | |
| $R_{DS(on)}$ at 25 °C (Ω) | $V_{GS} = 10$ V | 0.19 |
| Q_g Typ. (nC) | 106 | |
| Q_{gs} (nC) | 14 | |
| Q_{gd} (nC) | 33 | |
| Configuration | Single | |

FEATURES

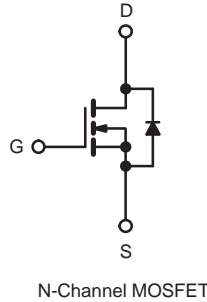
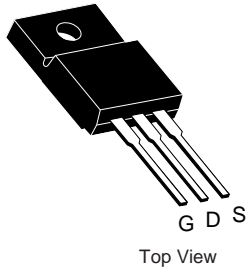
- Low figure-of-merit (FOM) $R_{on} \times Q_g$
- Low input capacitance (C_{iss})
- Reduced switching and conduction losses
- Ultra low gate charge (Q_g)
- Avalanche energy rated (UIS)



APPLICATIONS

- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- Lighting
 - High-intensity discharge (HID)
 - Fluorescent ballast lighting
- Industrial

TO-220 FULLPAK



| ABSOLUTE MAXIMUM RATINGS (T _C = 25 °C, unless otherwise noted) | | | | | |
|---|-------------------------|-------------------------|-----------------------------------|--------------|------|
| PARAMETER | | | SYMBOL | LIMIT | UNIT |
| Drain-Source Voltage | | | V _{DS} | 650 | V |
| Gate-Source Voltage | | | V _{GS} | ± 30 | |
| Continuous Drain Current (T _J = 150 °C) | V _{GS} at 10 V | T _C = 25 °C | I _D | 20 | A |
| | | T _C = 100 °C | | 13 | |
| Pulsed Drain Current ^a | | | I _{DM} | 53 | |
| Linear Derating Factor | | | | 1.67/1.5/0.3 | W/°C |
| Single Pulse Avalanche Energy ^b | | | E _{AS} | 360 | mJ |
| Maximum Power Dissipation | | | P _D | 200 | W |
| Operating Junction and Storage Temperature Range | | | T _J , T _{stg} | -55 to +150 | °C |
| Drain-Source Voltage Slope | T _J = 125 °C | | dV/dt | 50 | V/ns |
| Reverse Diode dV/dt ^d | | 3.1 | | | |
| Soldering Recommendations (Peak Temperature) ^c | for 10 s | | | 300 | °C |


Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$ V, starting $T_J = 25$ °C, $L = 28.2$ mH, $R_g = 25$ Ω , $I_{AS} = 4.5$ A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$, $dI/dt = 100$ A/ μ s, starting $T_J = 25$ °C.

THERMAL RESISTANCE RATINGS

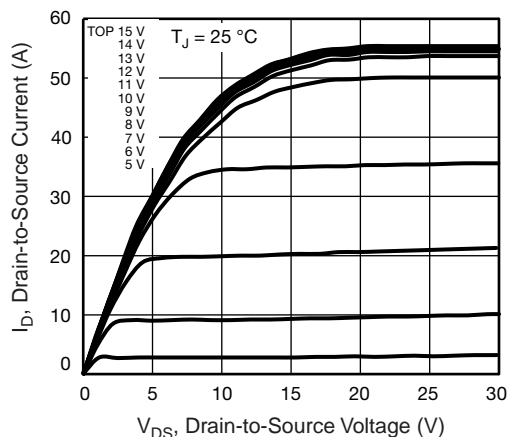
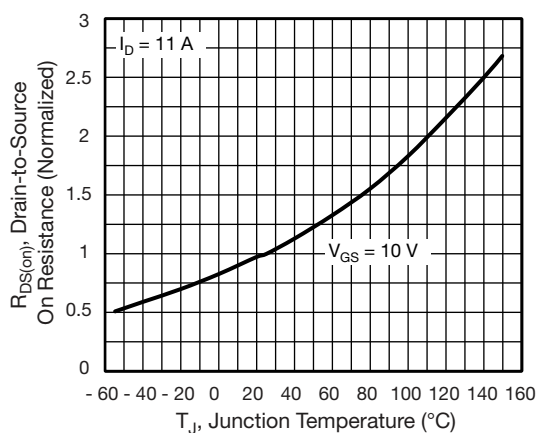
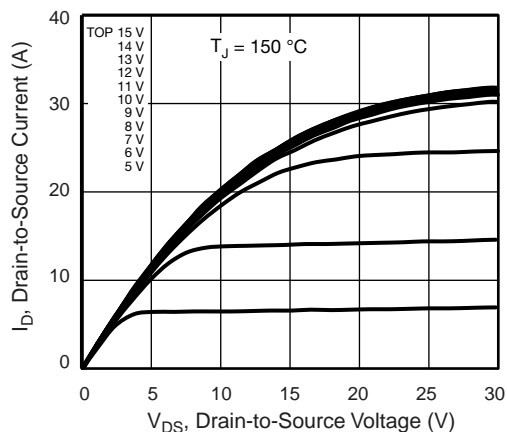
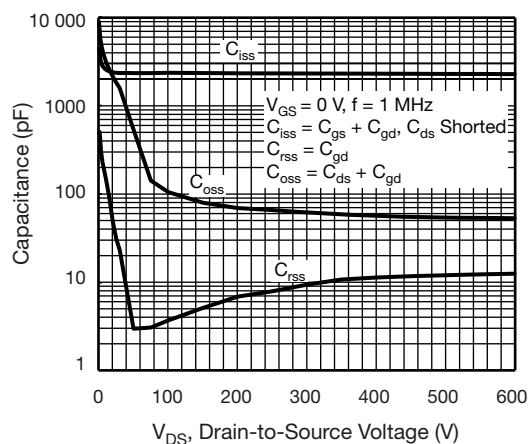
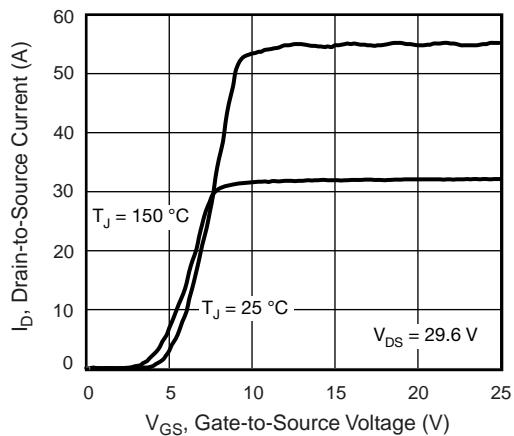
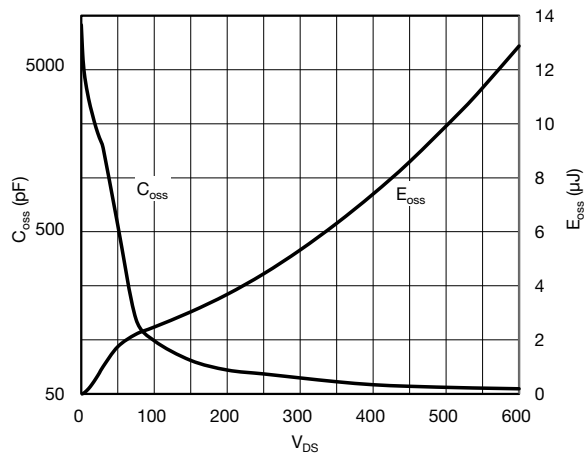
| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient | R_{thJA} | - | 62 | °C/W |
| Maximum Junction-to-Case (Drain) | R_{thJC} | - | 0.5 | |

SPECIFICATIONS ($T_J = 25\text{ }^{\circ}\text{C}$, unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
|---|---------------------|--|---|------|------|-----------|---------------------|
| Static | | | | | | | |
| Drain-Source Breakdown Voltage | V_{DS} | $V_{GS} = 0\text{ V}$, $I_D = 250\text{ }\mu\text{A}$ | | 650 | - | - | V |
| V_{DS} Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$, $I_D = 1\text{ mA}$ | | - | 0.67 | - | V/ $^\circ\text{C}$ |
| Gate-Source Threshold Voltage (N) | $V_{GS(th)}$ | $V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$ | | 2 | - | 5 | V |
| Gate-Source Leakage | I_{GSS} | $V_{GS} = \pm 20\text{ V}$ | | - | - | ± 100 | nA |
| | | $V_{GS} = \pm 30\text{ V}$ | | - | - | ± 1 | μA |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = 520\text{ V}$, $V_{GS} = 0\text{ V}$ | | - | - | 1 | μA |
| | | $V_{DS} = 520\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$ | | - | - | 500 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}$ | $I_D = 11\text{ A}$ | - | 0.19 | - | Ω |
| Forward Transconductance | g_{fs} | $V_{DS} = 30\text{ V}$, $I_D = 11\text{ A}$ | | - | 7.0 | - | S |
| Dynamic | | | | | | | |
| Input Capacitance | C_{iss} | $V_{GS} = 0\text{ V}$, $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$ | | - | 2322 | - | pF |
| Output Capacitance | C_{oss} | | | - | 105 | - | |
| Reverse Transfer Capacitance | C_{rss} | | | - | 4 | - | |
| Effective Output Capacitance, Energy Related ^a | $C_{o(er)}$ | $V_{DS} = 0\text{ V to } 520\text{ V}$, $V_{GS} = 0\text{ V}$ | | - | 84 | - | |
| Effective Output Capacitance, Time Related ^b | $C_{o(tr)}$ | | | - | 293 | - | |
| Total Gate Charge | Q_g | $V_{GS} = 10\text{ V}$ | $I_D = 11\text{ A}$, $V_{DS} = 520\text{ V}$ | - | 71 | 106 | nC |
| Gate-Source Charge | Q_{gs} | | | - | 14 | - | |
| Gate-Drain Charge | Q_{gd} | | | - | 33 | - | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD} = 520\text{ V}$, $I_D = 11\text{ A}$, $V_{GS} = 10\text{ V}$, $R_g = 9.1\text{ }\Omega$ | | - | 22 | 44 | ns |
| Rise Time | t_r | | | - | 34 | 68 | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | - | 68 | 102 | |
| Fall Time | t_f | | | - | 42 | 84 | |
| Gate Input Resistance | R_g | $f = 1\text{ MHz}$, open drain | | - | 0.78 | - | Ω |
| Drain-Source Body Diode Characteristics | | | | | | | |
| Continuous Source-Drain Diode Current | I_S | MOSFET symbol showing the integral reverse p - n junction diode  | | - | - | 21 | A |
| Pulsed Diode Forward Current | I_{SM} | | | - | - | 53 | |
| Diode Forward Voltage | V_{SD} | $T_J = 25\text{ }^\circ\text{C}$, $I_S = 11\text{ A}$, $V_{GS} = 0\text{ V}$ | | - | 0.9 | 1.2 | V |
| Reverse Recovery Time | t_{rr} | $T_J = 25\text{ }^\circ\text{C}$, $I_F = I_S = 11\text{ A}$, $dI/dt = 100\text{ A}/\mu\text{s}$, $V_R = 25\text{ V}$ | | - | 160 | - | ns |
| Reverse Recovery Charge | Q_{rr} | | | - | 1.2 | - | μC |
| Reverse Recovery Current | I_{RRM} | | | - | 14 | - | A |

Notes

- a. $C_{oss(er)}$ is a fixed capacitance that gives the same energy as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DSS} .
 b. $C_{oss(tr)}$ 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 - C_{oss} and E_{oss} vs. V_{DS}

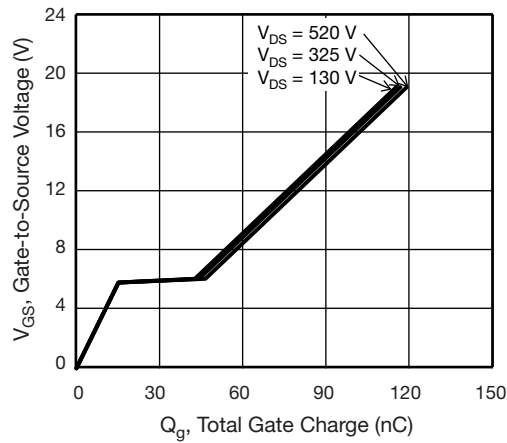


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

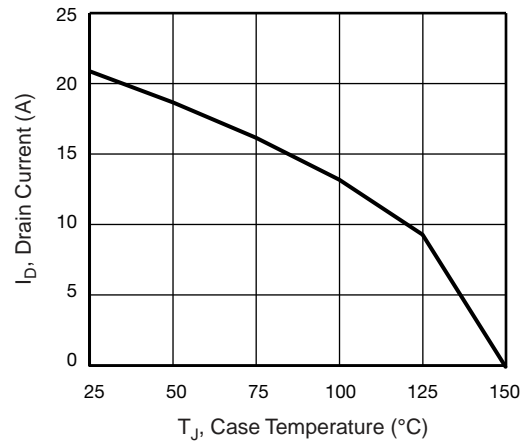


Fig. 10 - Maximum Drain Current vs. Case Temperature

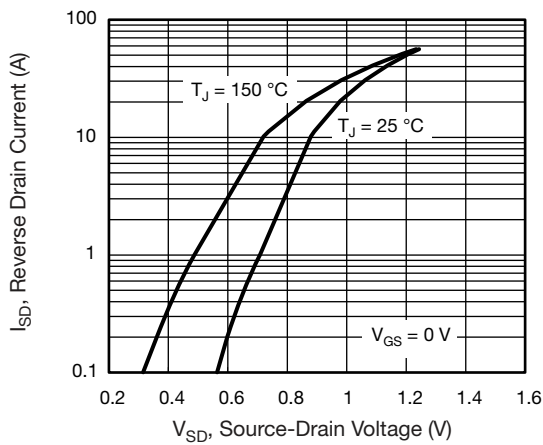


Fig. 8 - Typical Source-Drain Diode Forward Voltage

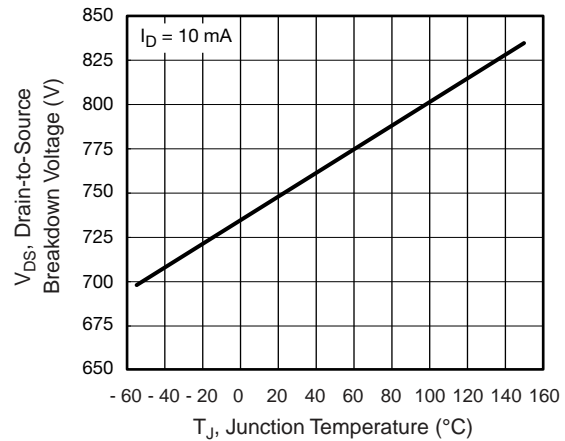


Fig. 11 - Temperature vs. Drain-to-Source Voltage

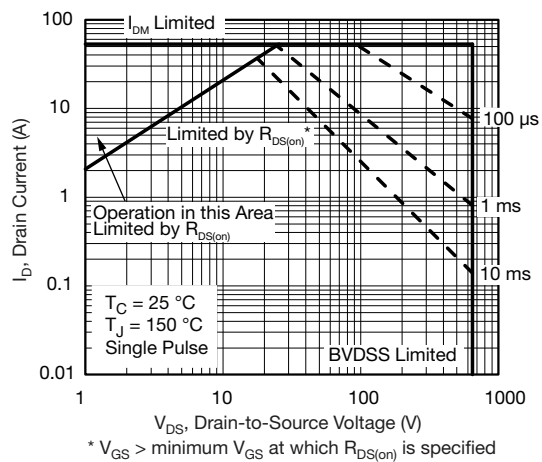


Fig. 9 - Maximum Safe Operating Area

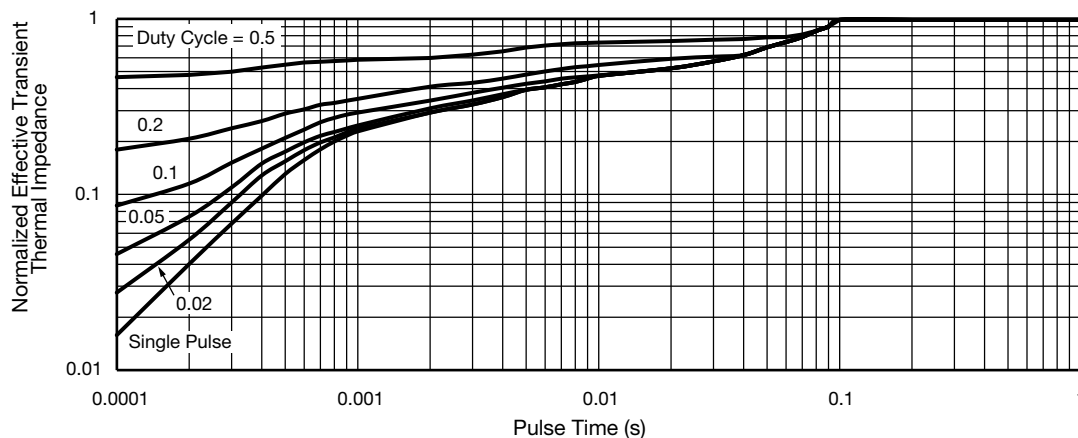


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case

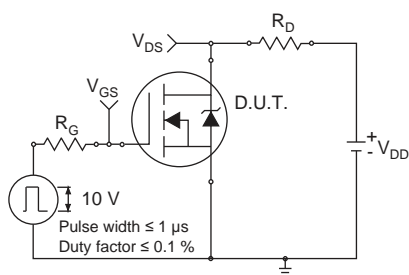


Fig. 13 - Switching Time Test Circuit

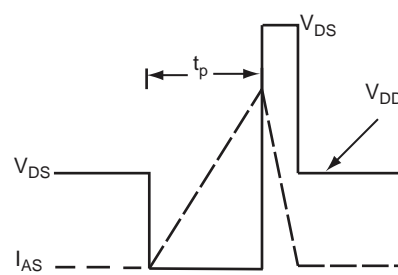


Fig. 16 - Unclamped Inductive Waveforms

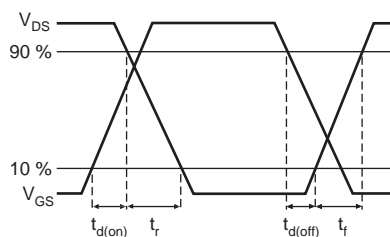


Fig. 14 - Switching Time Waveforms

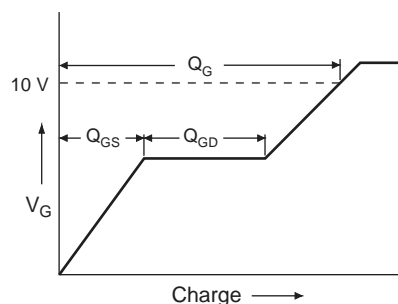


Fig. 17 - Basic Gate Charge Waveform

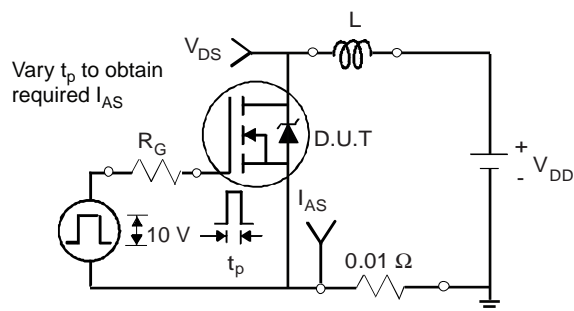


Fig. 15 - Unclamped Inductive Test Circuit

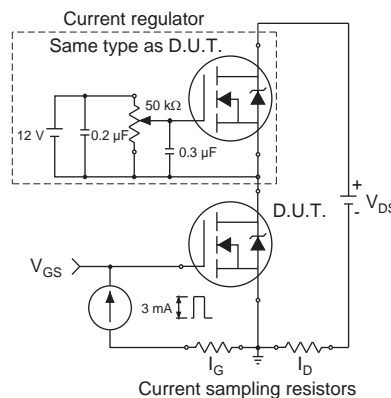
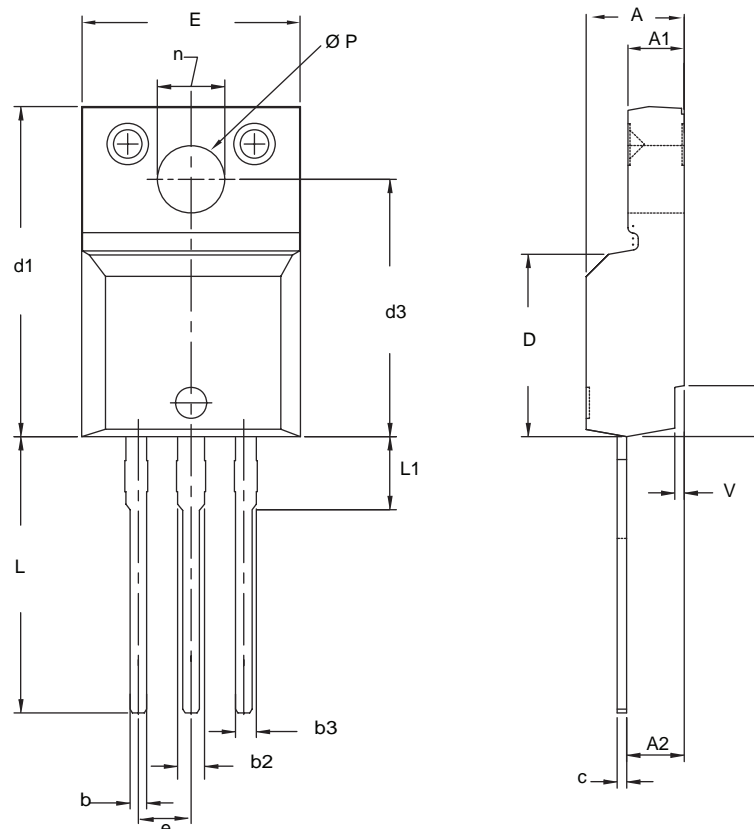


Fig. 18 - Gate Charge Test Circuit

TO-220 FULLPAK (HIGH VOLTAGE)

| 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 |

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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.

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