

## 2SK1088-M-VB Datasheet

### N-Channel 200 V (D-S) MOSFET

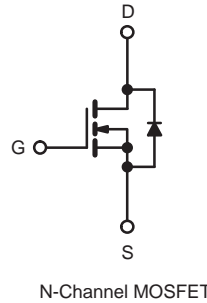
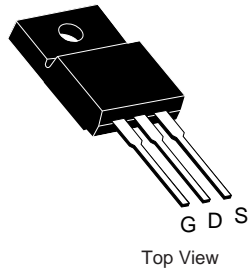
| PRODUCT SUMMARY            |                              |
|----------------------------|------------------------------|
| V <sub>DS</sub> (V)        | 200                          |
| R <sub>DS(on)</sub> (Ω)    | V <sub>GS</sub> = 10 V 0.058 |
| Q <sub>g</sub> (Max.) (nC) | 64                           |
| Q <sub>gs</sub> (nC)       | 12                           |
| Q <sub>gd</sub> (nC)       | 30                           |
| Configuration              | Single                       |

#### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- Surface Mount
- Low-Profile Through-Hole
- Available in Tape and Reel
- Dynamic dV/dt Rating
- 150 °C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Compliant to RoHS Directive 2002/95/EC



TO-220 FULLPAK



| ABSOLUTE MAXIMUM RATINGS (T <sub>C</sub> = 25 °C, unless otherwise noted) |                                   |                         |                  |      |
|---|-----------------------------------|-------------------------|------------------|------|
| PARAMETER   | SYMBOL                            |                         | LIMIT            | UNIT |
| Drain-Source Voltage  | V <sub>DS</sub>                   |                         | 200              | V    |
| Gate-Source Voltage   | V <sub>GS</sub>                   |                         | ± 20             |      |
| Continuous Drain Current  | V <sub>GS</sub> at 10 V           | T <sub>C</sub> = 25 °C  | 20               | A    |
|   |                                   | T <sub>C</sub> = 100 °C | 14               |      |
| Pulsed Drain Current <sup>a, e</sup>                                      | I <sub>DM</sub>                   |                         | 72               |      |
| Linear Derating Factor  |                                   |                         | 1.0              | W/°C |
| Single Pulse Avalanche Energy <sup>b, e</sup>                             | E <sub>AS</sub>                   |                         | 580              | mJ   |
| Avalanche Current <sup>a</sup>  | I <sub>AR</sub>                   |                         | 20               | A    |
| Repetitive Avalanche Energy <sup>a</sup>                                  | E <sub>AR</sub>                   |                         | 13               | mJ   |
| Maximum Power Dissipation   | T <sub>C</sub> = 25 °C            |                         | 42               | W    |
|   | T <sub>A</sub> = 25 °C            |                         | 13               |      |
| Peak Diode Recovery dV/dt <sup>c, e</sup>                                 | dV/dt                             |                         | 5.0              | V/ns |
| Operating Junction and Storage Temperature Range                          | T <sub>J</sub> , T <sub>stg</sub> |                         | - 55 to + 150    | °C   |
| Soldering Recommendations (Peak Temperature)                              | for 10 s                          |                         | 300 <sup>d</sup> |      |

**Notes**

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- V<sub>DD</sub> = 50 V, starting T<sub>J</sub> = 25 °C, L = 2.7 mH, R<sub>g</sub> = 25 Ω, I<sub>AS</sub> = 18 A (see fig. 12).
- I<sub>SD</sub> ≤ 20 A, di/dt ≤ 150 A/μs, V<sub>DD</sub> ≤ V<sub>DS</sub>, T<sub>J</sub> ≤ 150 °C.
- 1.6 mm from case.


**THERMAL RESISTANCE RATINGS**

| PARAMETER  | SYMBOL     | TYP. | MAX. | UNIT |
|--|------------|------|------|------|
| Maximum Junction-to-Ambient (PCB Mounted, Steady-State) <sup>a</sup> | $R_{thJA}$ | -    | 40   | °C/W |
| Maximum Junction-to-Case (Drain)                                     | $R_{thJC}$ | -    | 1.0  |      |

**Note**

a. When mounted on 1" square PCB (FR-4 or G-10 material).

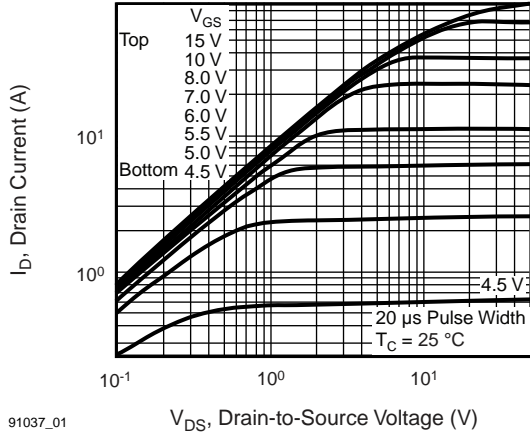
**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , unless otherwise noted)

| PARAMETER                                      | SYMBOL              | TEST CONDITIONS  | MIN. | TYP.  | MAX.      | UNIT          |
|--|---------------------|--|------|-------|-----------|---------------|
| <b>Static</b>                                  |                     |  |      |       |           |               |
| Drain-Source Breakdown Voltage                 | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$  | 200  | -     | -         | V             |
| $V_{DS}$ Temperature Coefficient               | $\Delta V_{DS}/T_J$ | Reference to $25\text{ °C}$ , $I_D = 1\text{ mA}^c$  | -    | 0.29  | -         | V/°C          |
| Gate-Source Threshold Voltage                  | $V_{GS(th)}$        | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$  | 2.0  | -     | 4.0       | V             |
| Gate-Source Leakage                            | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$   | -    | -     | $\pm 100$ | nA            |
| Zero Gate Voltage Drain Current                | $I_{DSS}$           | $V_{DS} = 200\text{ V}, V_{GS} = 0\text{ V}$   | -    | -     | 25        | $\mu\text{A}$ |
|  |                     | $V_{DS} = 160\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ °C}$  | -    | -     | 250       |               |
| Drain-Source On-State Resistance               | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$   $I_D = 11\text{ A}^b$   | -    | 0.058 | -         | $\Omega$      |
| Forward Transconductance                       | $g_{fs}$            | $V_{DS} = 50\text{ V}, I_D = 11\text{ A}^d$  | 6.7  | -     | -         | S             |
| <b>Dynamic</b>                                 |                     |  |      |       |           |               |
| Input Capacitance                              | $C_{iss}$           | $V_{GS} = 0\text{ V},$<br>$V_{DS} = 25\text{ V},$<br>$f = 1.0\text{ MHz}$ , see fig. 5 <sup>d</sup>  | -    | 1300  | -         | pF            |
| Output Capacitance                             | $C_{oss}$           |  | -    | 430   | -         |               |
| Reverse Transfer Capacitance                   | $C_{rss}$           |  | -    | 130   | -         |               |
| Total Gate Charge                              | $Q_g$               | $V_{GS} = 10\text{ V}$   $I_D = 20\text{ A}, V_{DS} = 160\text{ V},$<br>see fig. 6 and 13 <sup>b, c</sup>  | -    | -     | 70        | nC            |
| Gate-Source Charge                             | $Q_{gs}$            |  | -    | -     | 13        |               |
| Gate-Drain Charge                              | $Q_{gd}$            |  | -    | -     | 39        |               |
| Turn-On Delay Time                             | $t_{d(on)}$         | $V_{DD} = 100\text{ V}, I_D = 20\text{ A},$<br>$R_g = 9.1\text{ }\Omega, R_D = 5.4\text{ }\Omega$ , see fig. 10 <sup>b, c</sup>                      | -    | 14    | -         | ns            |
| Rise Time                                      | $t_r$               |  | -    | 51    | -         |               |
| Turn-Off Delay Time                            | $t_{d(off)}$        |  | -    | 45    | -         |               |
| Fall Time                                      | $t_f$               |  | -    | 36    | -         |               |
| <b>Drain-Source Body Diode Characteristics</b> |                     |  |      |       |           |               |
| Continuous Source-Drain Diode Current          | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode  | -    | -     | 20        | A             |
| Pulsed Diode Forward Current <sup>a</sup>      | $I_{SM}$            |  | -    | -     | 72        |               |
| Body Diode Voltage                             | $V_{SD}$            | $T_J = 25\text{ °C}, I_S = 20\text{ A}, V_{GS} = 0\text{ V}^b$   | -    | -     | 2.0       | V             |
| Body Diode Reverse Recovery Time               | $t_{rr}$            | $T_J = 25\text{ °C}, I_F = 20\text{ A}, di/dt = 100\text{ A}/\mu\text{s}^b, c$   | -    | 300   | 610       | ns            |
| Body Diode Reverse Recovery Charge             | $Q_{rr}$            |  | -    | 3.4   | 7.1       | $\mu\text{C}$ |
| Forward Turn-On Time                           | $t_{on}$            | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )  |      |       |           |               |

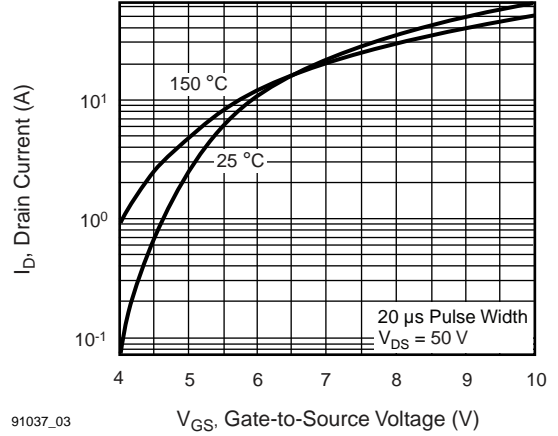
**Notes**

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- Uses IRF640/SiHF640 data and test conditions.

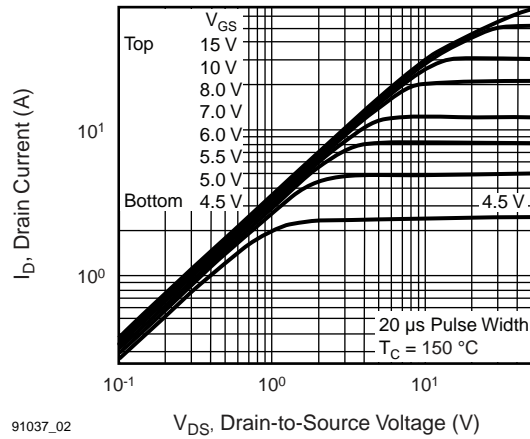
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



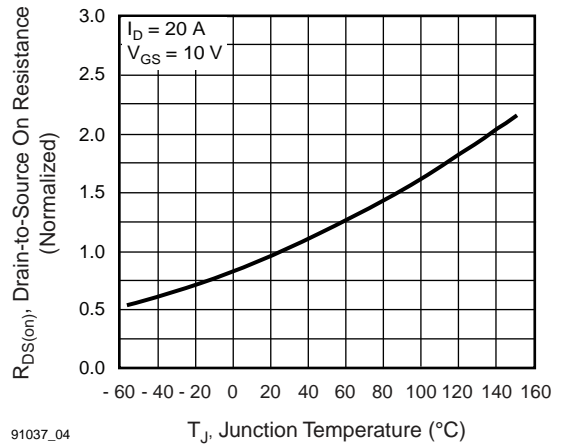
**Fig. 1 - Typical Output Characteristics,  $T_J = 25\text{ }^\circ\text{C}$**



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 2 - Typical Output Characteristics,  $T_J = 175\text{ }^\circ\text{C}$**



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

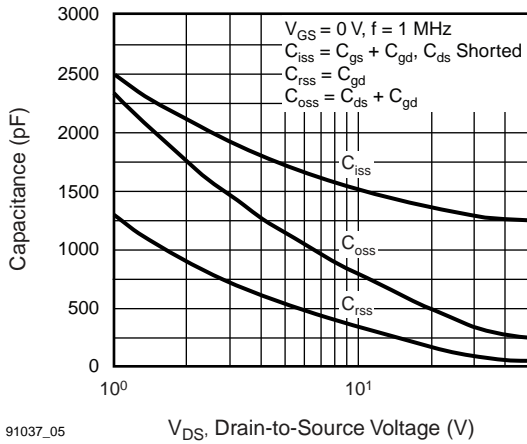


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

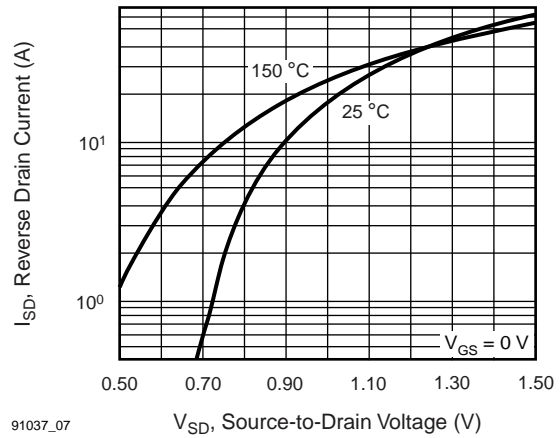


Fig. 7 - Typical Source-Drain Diode Forward Voltage



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

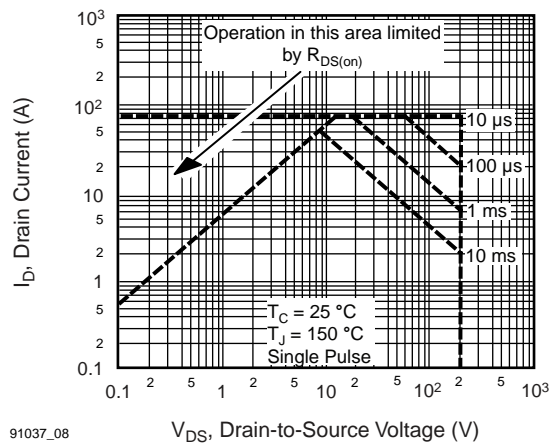


Fig. 8 - Maximum Safe Operating Area

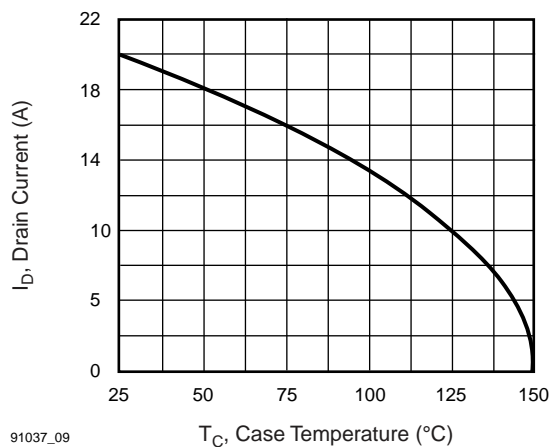


Fig. 9 - Maximum Drain Current vs. Case Temperature

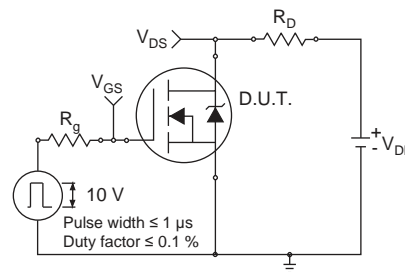


Fig. 10a - Switching Time Test Circuit

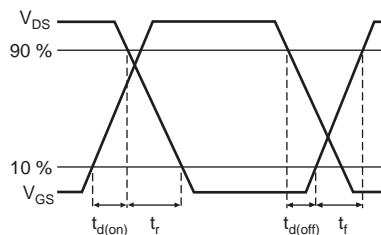


Fig. 10b - Switching Time Waveforms

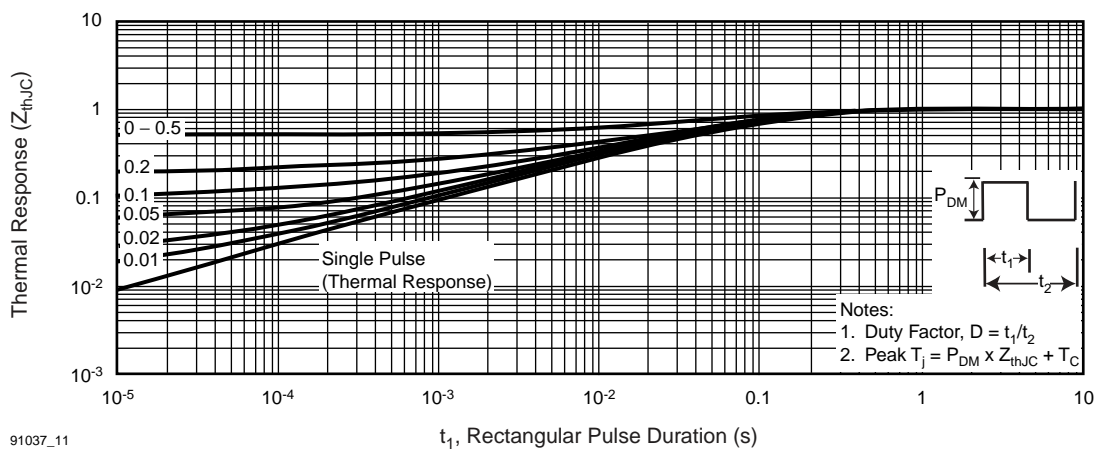


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

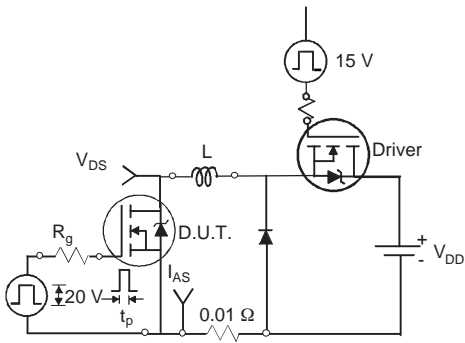


Fig. 12a - Unclamped Inductive Test Circuit



Fig. 12b - Unclamped Inductive Waveforms

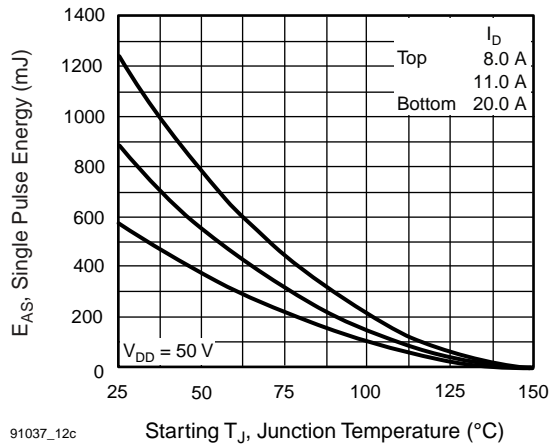


Fig. 12c - Maximum Avalanche Energy vs. Drain Current



Fig. 13a - Basic Gate Charge Waveform

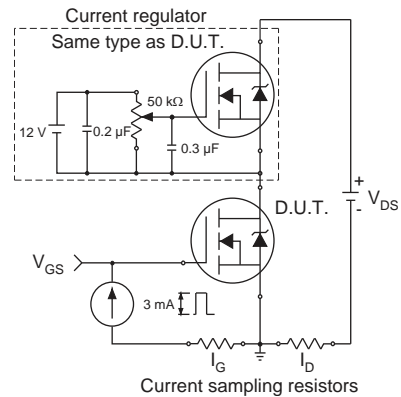
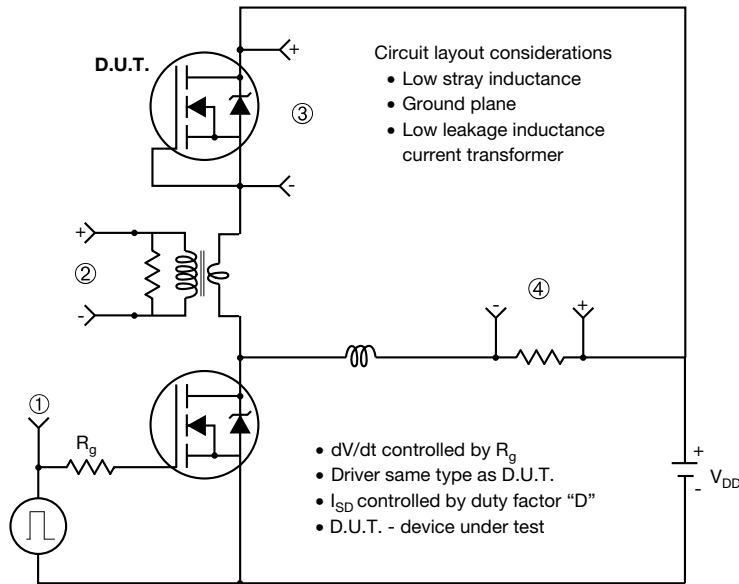


Fig. 13b - Gate Charge Test Circuit

**Peak Diode Recovery dV/dt Test Circuit**

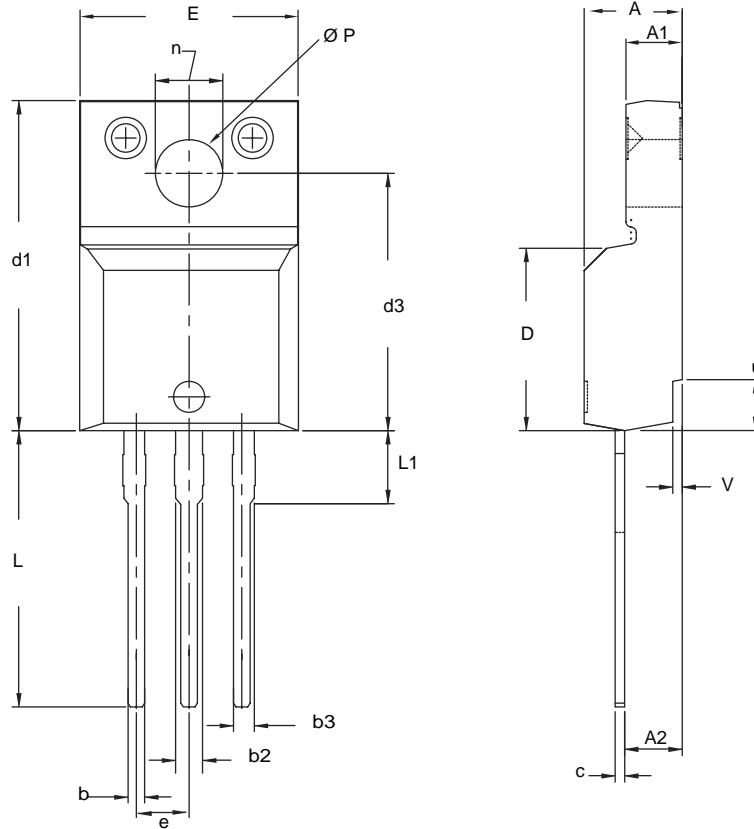


**Note**

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

**Fig. 14 - For N-Channel**

**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 |

ECN: X09-0126-Rev. B, 26-Oct-09  
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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