

IRFS4321PbF IRFSL4321PbF

HEXFET® Power MOSFET

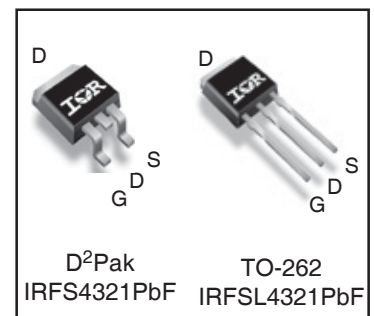
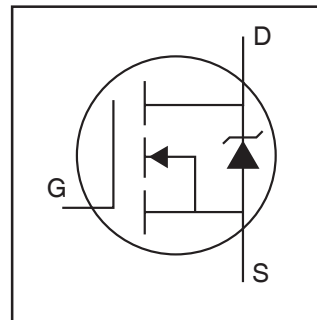
Applications

- Motion Control Applications
- High Efficiency Synchronous Rectification in SMPS
- Uninterruptible Power Supply
- Hard Switched and High Frequency Circuits

Benefits

- Low $R_{DS(on)}$ Reduces Losses
- Low Gate Charge Improves the Switching Performance
- Improved Diode Recovery Improves Switching & EMI Performance
- 30V Gate Voltage Rating Improves Robustness
- Fully Characterized Avalanche SOA

| | |
|---|--------------|
| V_{DSS} | 150V |
| $R_{DS(on)}$ typ. max. | 12mΩ |
| | 15mΩ |
| I_D | 85A ① |



| | | |
|----------|----------|----------|
| G | D | S |
| Gate | Drain | Source |

Absolute Maximum Ratings

| Symbol | Parameter | Max. | Units | |
|-----------------------------------|--|--------------|-------|----|
| I_D @ $T_C = 25^\circ\text{C}$ | Continuous Drain Current, V_{GS} @ 10V | 85 ① | A | |
| I_D @ $T_C = 100^\circ\text{C}$ | Continuous Drain Current, V_{GS} @ 10V | 60 | | |
| I_{DM} | Pulsed Drain Current ② | 330 | | |
| P_D @ $T_C = 25^\circ\text{C}$ | Maximum Power Dissipation | 350 | W | |
| | Linear Derating Factor | 2.3 | W/°C | |
| V_{GS} | Gate-to-Source Voltage | ±30 | V | |
| E_{AS} (Thermally limited) | Single Pulse Avalanche Energy ③ | 120 | mJ | |
| T_J | Operating Junction and | -55 to + 175 | | °C |
| T_{STG} | Storage Temperature Range | | | |
| | Soldering Temperature, for 10 seconds (1.6mm from case) | 300 | | |

Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|-----------------|-----------------------|------|-------|-------|
| $R_{\theta JC}$ | Junction-to-Case ⑤ | — | 0.43* | °C/W |
| $R_{\theta JA}$ | Junction-to-Ambient ⑤ | — | 40 | |

* $R_{\theta JC}$ (end of life) for D²Pak and TO-262 = 0.65°C/W. This is the maximum measured value after 1000 temperature cycles from -55 to 150°C and is accounted for by the physical wearout of the die attach medium.

Notes ① through ⑤ are on page 2

Static @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

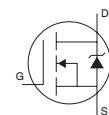
| Symbol | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---------------------------------|--------------------------------------|------|------|------|----------------------|---|
| $V_{(BR)DSS}$ | Drain-to-Source Breakdown Voltage | 150 | — | — | V | $V_{GS} = 0V, I_D = 250\mu A$ |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | — | 150 | — | mV/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}, I_D = 1\text{mA}$ ② |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | 12 | 15 | m Ω | $V_{GS} = 10V, I_D = 33A$ ③ |
| $V_{GS(th)}$ | Gate Threshold Voltage | 3.0 | — | 5.0 | V | $V_{DS} = V_{GS}, I_D = 250\mu A$ |
| I_{DSS} | Drain-to-Source Leakage Current | — | — | 20 | μA | $V_{DS} = 150V, V_{GS} = 0V$ |
| | | — | — | 1.0 | mA | $V_{DS} = 150V, V_{GS} = 0V, T_J = 125^\circ\text{C}$ |
| I_{GSS} | Gate-to-Source Forward Leakage | — | — | 100 | nA | $V_{GS} = 20V$ |
| | Gate-to-Source Reverse Leakage | — | — | -100 | nA | $V_{GS} = -20V$ |
| $R_{G(int)}$ | Internal Gate Resistance | — | 0.8 | — | Ω | |

Dynamic @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Units | Conditions |
|--------------|---------------------------------|------|------|------|-------|---------------------------|
| gfs | Forward Transconductance | 130 | — | — | S | $V_{DS} = 25V, I_D = 50A$ |
| Q_g | Total Gate Charge | — | 71 | 110 | nC | $I_D = 50A$ |
| Q_{gs} | Gate-to-Source Charge | — | 24 | — | nC | $V_{DS} = 75V$ |
| Q_{gd} | Gate-to-Drain ("Miller") Charge | — | 21 | — | nC | $V_{GS} = 10V$ ④ |
| $t_{d(on)}$ | Turn-On Delay Time | — | 18 | — | ns | $V_{DD} = 98V$ |
| t_r | Rise Time | — | 60 | — | ns | $I_D = 50A$ |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 25 | — | ns | $R_G = 2.5\Omega$ |
| t_f | Fall Time | — | 35 | — | ns | $V_{GS} = 10V$ ④ |
| C_{iss} | Input Capacitance | — | 4460 | — | pF | $V_{GS} = 0V$ |
| C_{oss} | Output Capacitance | — | 390 | — | pF | $V_{DS} = 50V$ |
| C_{rss} | Reverse Transfer Capacitance | — | 82 | — | pF | $f = 1.0\text{MHz}$ |

Diode Characteristics

| Symbol | Parameter | Min. | Typ. | Max. | Units | Conditions |
|-----------|---|--|------|------|-------|--|
| I_S | Continuous Source Current (Body Diode) | — | — | 85① | A | MOSFET symbol showing the integral reverse p-n junction diode. |
| I_{SM} | Pulsed Source Current (Body Diode) ② | — | — | 330 | A | |
| V_{SD} | Diode Forward Voltage | — | — | 1.3 | V | $T_J = 25^\circ\text{C}, I_S = 50A, V_{GS} = 0V$ ④ |
| t_{rr} | Reverse Recovery Time | — | 89 | 130 | ns | $I_D = 50A$ |
| Q_{rr} | Reverse Recovery Charge | — | 300 | 450 | nC | $V_R = 128V,$ |
| I_{RRM} | Reverse Recovery Current | — | 6.5 | — | A | $di/dt = 100A/\mu s$ ④ |
| t_{on} | Forward Turn-On Time | Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD) | | | | |

**Notes:**

- ① Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 75A
- ② Repetitive rating; pulse width limited by max. junction temperature.
- ③ Limited by T_{Jmax} , starting $T_J = 25^\circ\text{C}$, $L = 0.096\text{mH}$
 $R_G = 25\Omega, I_{AS} = 50A, V_{GS} = 10V$. Part not recommended for use above this value.

- ④ Pulse width $\leq 400\mu s$; duty cycle $\leq 2\%$.
- ⑤ R_θ is measured at T_J approximately 90°C

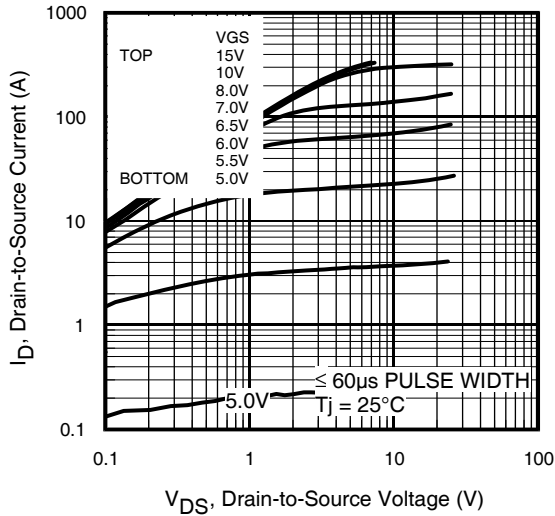


Fig 1. Typical Output Characteristics

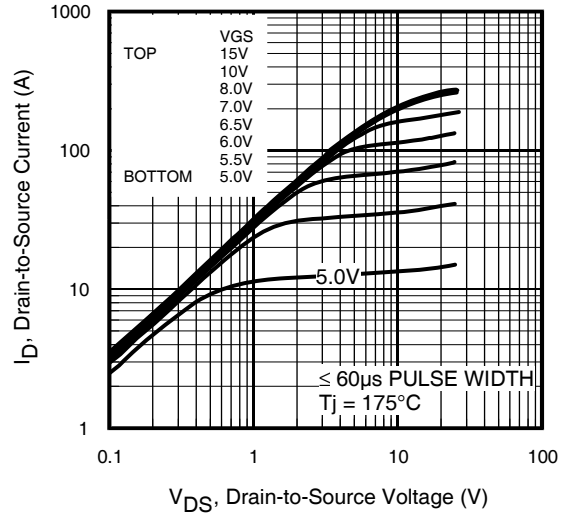


Fig 2. Typical Output Characteristics

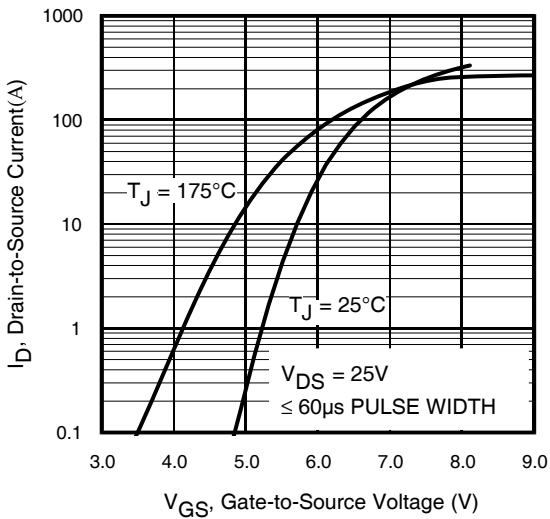


Fig 3. Typical Transfer Characteristics

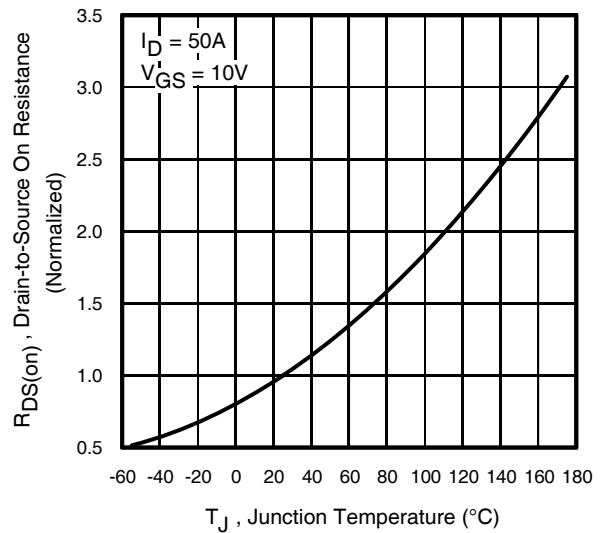


Fig 4. Normalized On-Resistance vs. Temperature

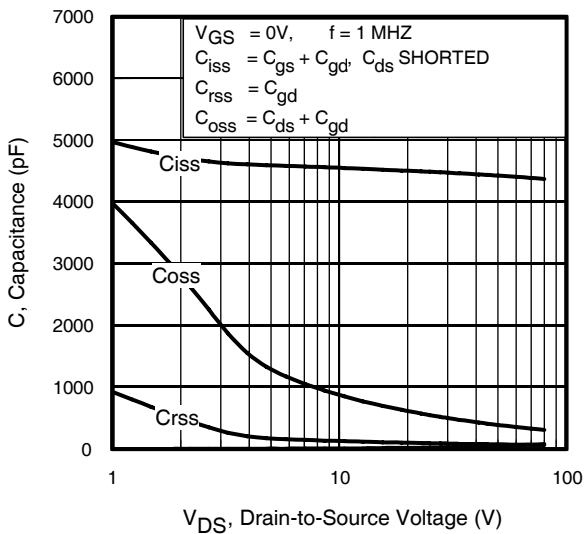


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

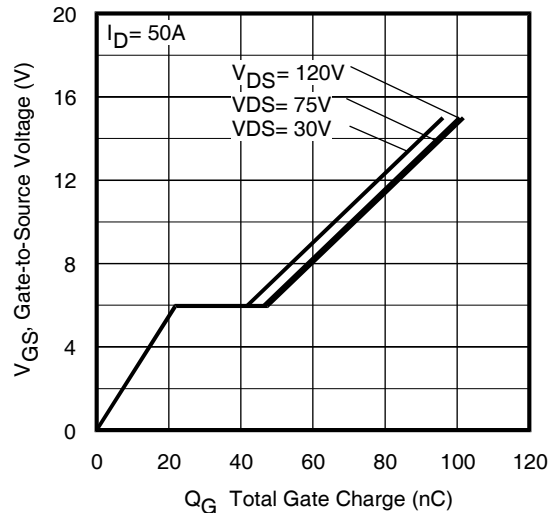


Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage

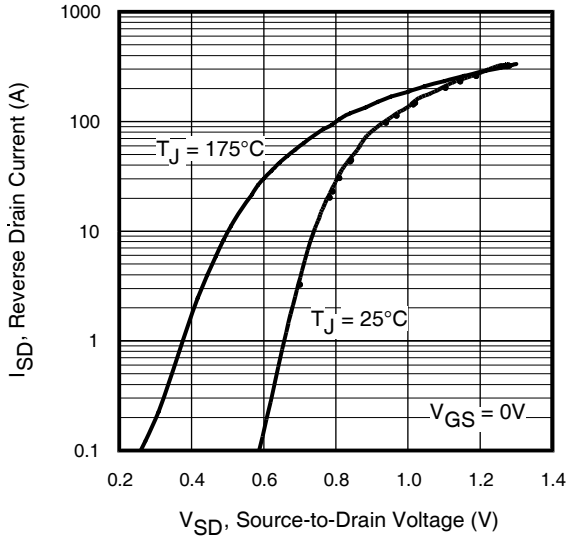


Fig 7. Typical Source-Drain Diode Forward Voltage

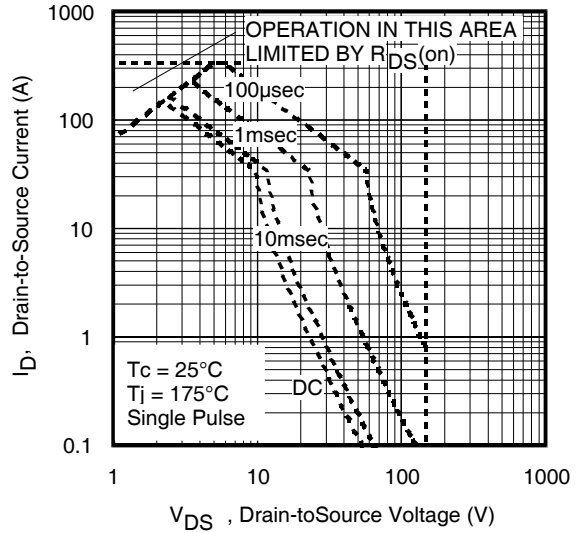


Fig 8. Maximum Safe Operating Area

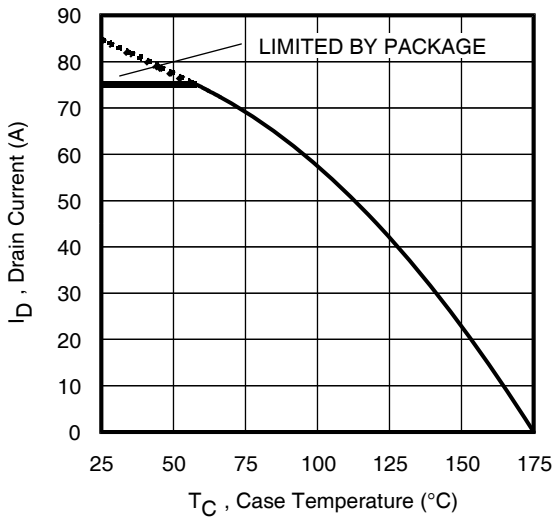


Fig 9. Maximum Drain Current vs. Case Temperature

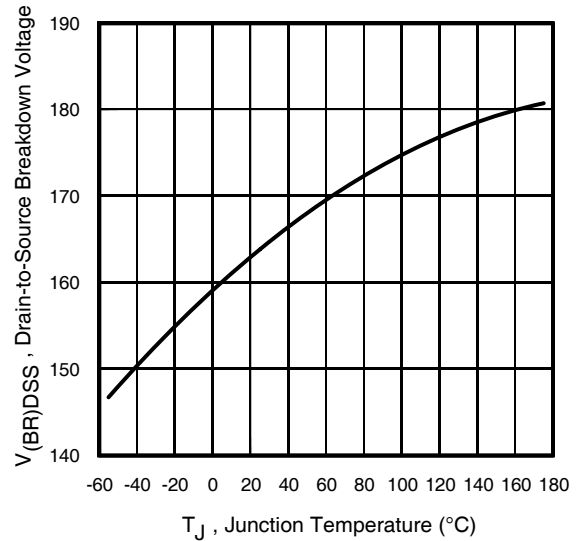


Fig 10. Drain-to-Source Breakdown Voltage

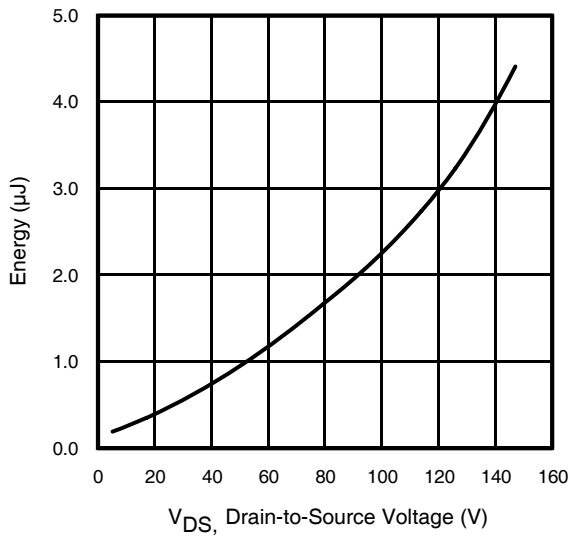


Fig 11. Typical C_{OSS} Stored Energy

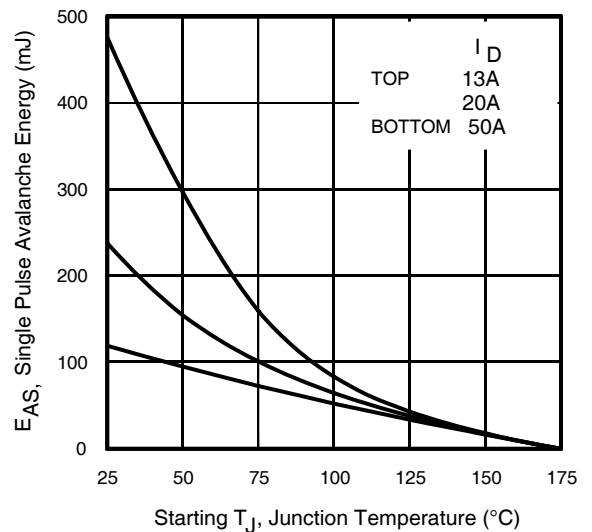


Fig 12. Maximum Avalanche Energy Vs. Drain Current

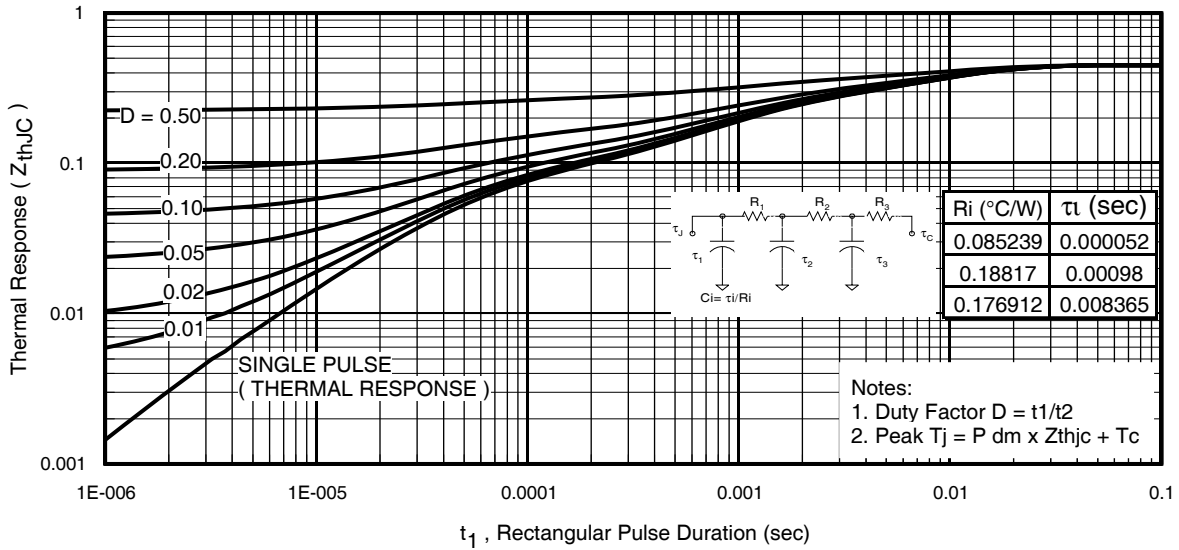


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

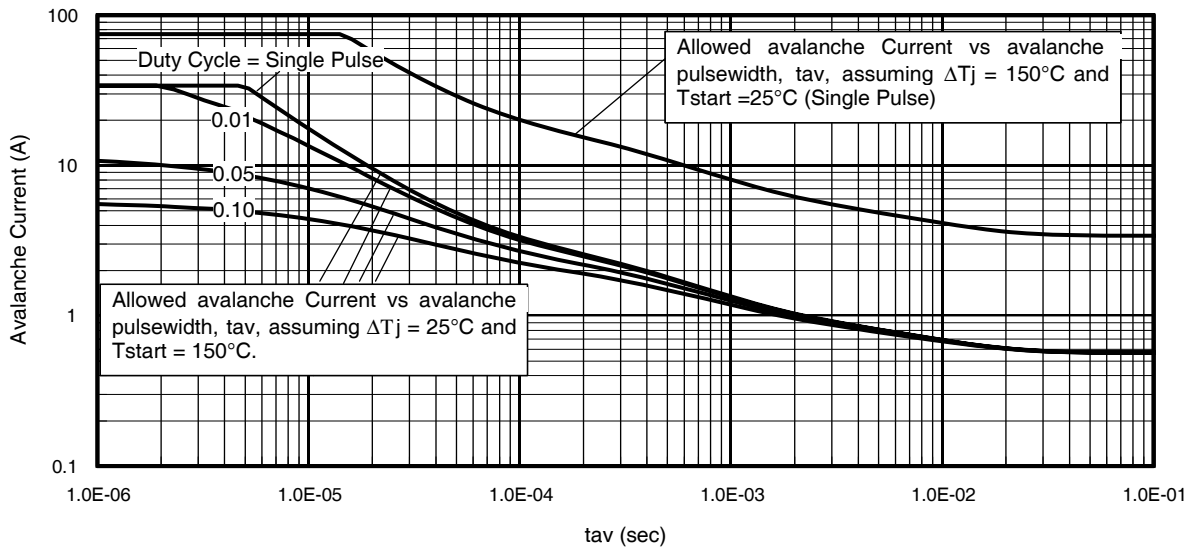
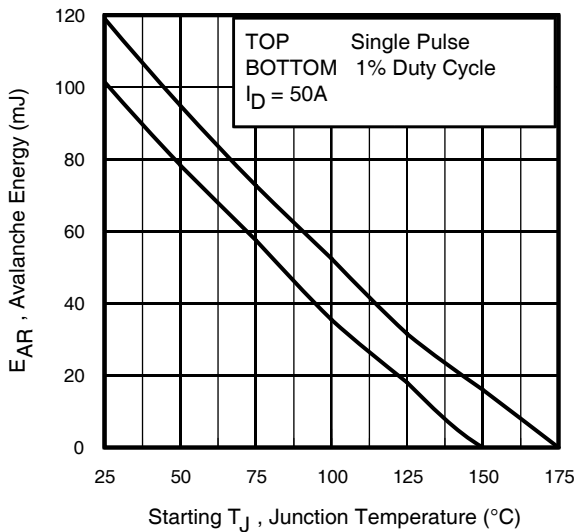


Fig 14. Typical Avalanche Current vs. Pulsewidth



Notes on Repetitive Avalanche Curves, Figures 14, 15:
(For further info, see AN-1005 at www.irf.com)

1. Avalanche failures assumption:
Purely a thermal phenomenon and failure occurs at a temperature far in excess of T_{jmax} . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as T_{jmax} is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 16a, 16b.
4. $P_{D(ave)}$ = Average power dissipation per single avalanche pulse.
5. BV = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6. I_{av} = Allowable avalanche current.
7. ΔT = Allowable rise in junction temperature, not to exceed T_{jmax} (assumed as 25°C in Figure 14, 15).
 t_{av} = Average time in avalanche.
 D = Duty cycle in avalanche = $t_{av} \cdot f$
 $Z_{thJC}(D, t_{av})$ = Transient thermal resistance, see Figures 13)

$$P_{D(ave)} = 1/2 (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$

$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$

Fig 15. Maximum Avalanche Energy vs. Temperature

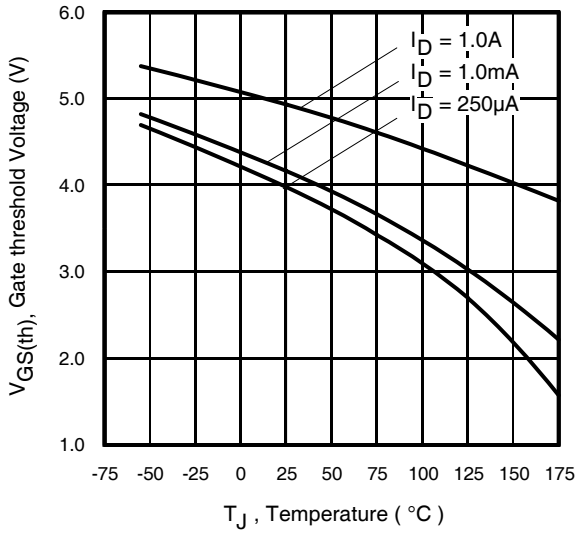


Fig 16. Threshold Voltage Vs. Temperature

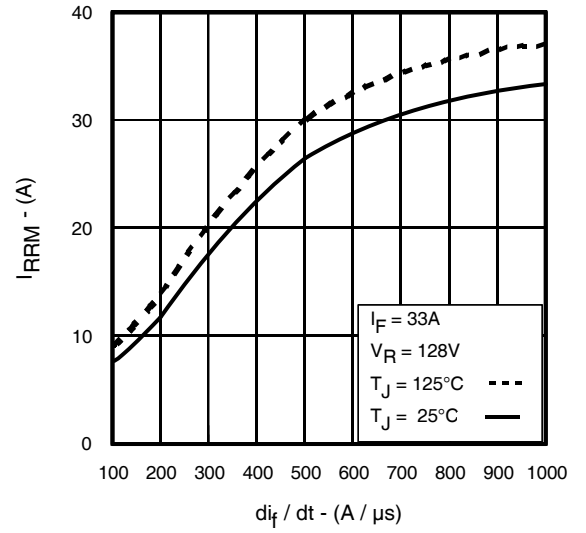


Fig. 17 - Typical Recovery Current vs. di_f/dt

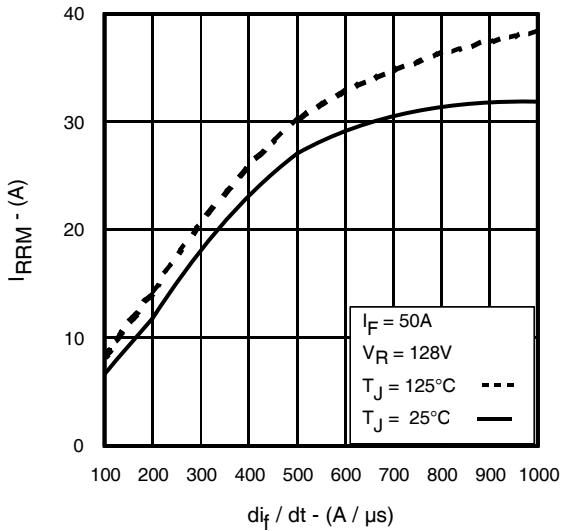


Fig. 18 - Typical Recovery Current vs. di_f/dt

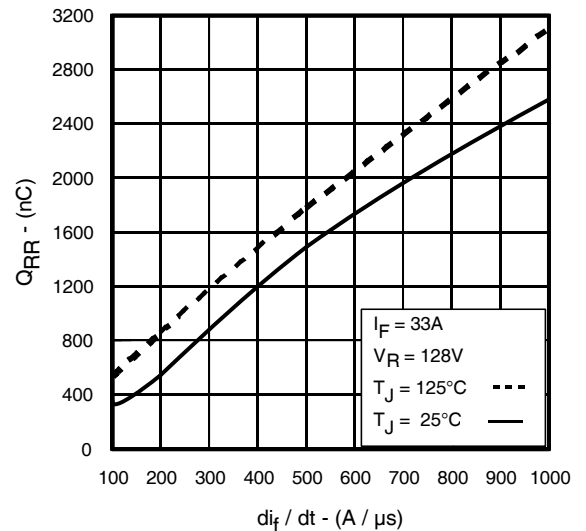


Fig. 19 - Typical Stored Charge vs. di_f/dt

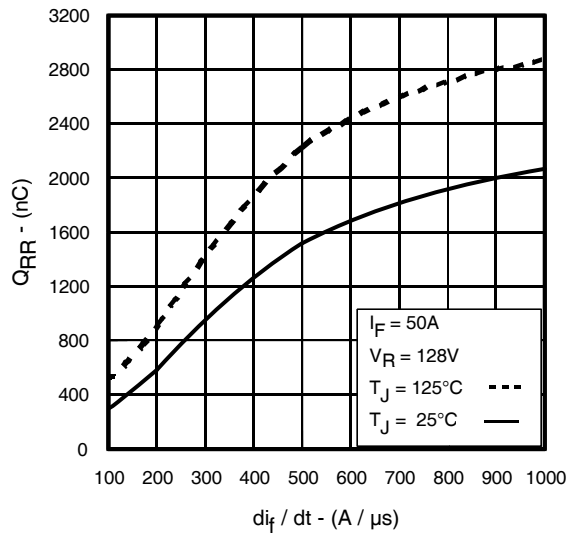
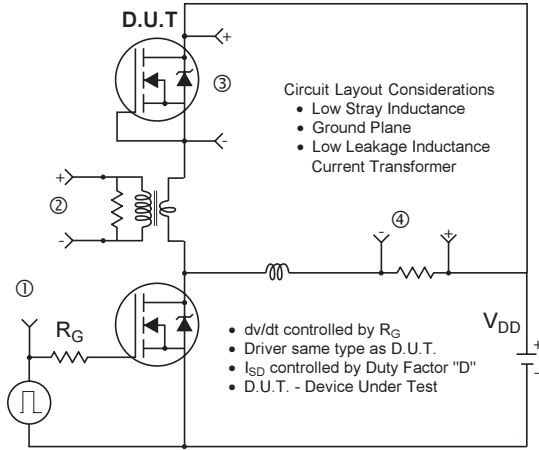


Fig. 20 - Typical Stored Charge vs. di_f/dt



* $V_{GS} = 5V$ for Logic Level Devices

Fig 21. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET[®] Power MOSFETs

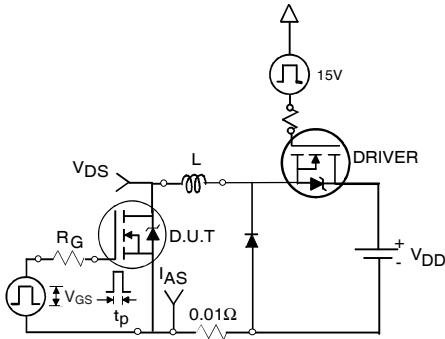


Fig 22a. Unclamped Inductive Test Circuit



Fig 22b. Unclamped Inductive Waveforms

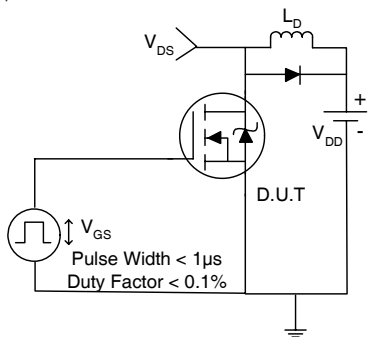


Fig 23a. Switching Time Test Circuit



Fig 23b. Switching Time Waveforms

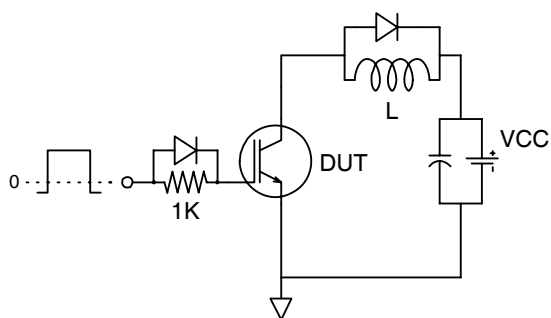
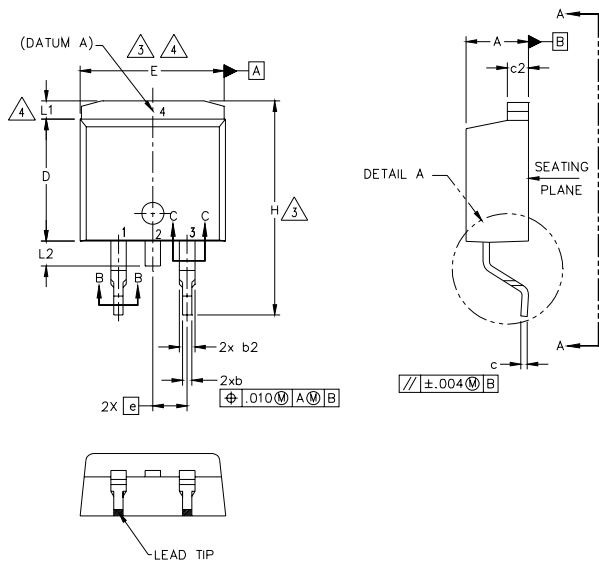


Fig 24a. Gate Charge Test Circuit



Fig 24b. Gate Charge Waveform

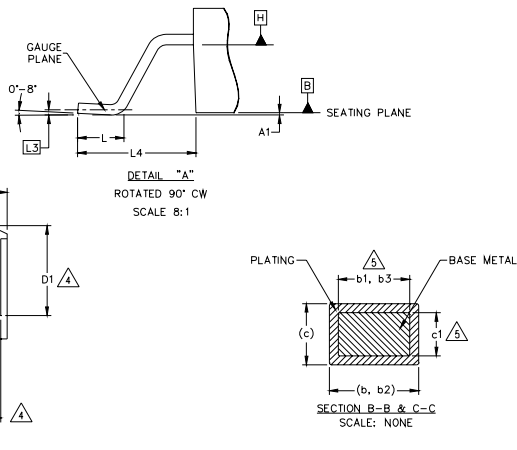
D²Pak Package Outline (Dimensions are shown in millimeters (inches))



| SYMBOL | DIMENSIONS | | | | NOTES |
|--------|-------------|-------|----------|------|--|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | 5 5 5 3 4 3,4 4 4 |
| A1 | 0.00 | 0.254 | .000 | .010 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | |
| b2 | 1.14 | 1.78 | .045 | .070 | |
| b3 | 1.14 | 1.73 | .045 | .068 | |
| c | 0.38 | 0.74 | .015 | .029 | |
| c1 | 0.38 | 0.58 | .015 | .023 | |
| c2 | 1.14 | 1.65 | .045 | .065 | |
| D | 8.38 | 9.65 | .330 | .380 | |
| D1 | 6.86 | - | .270 | - | |
| E | 9.65 | 10.67 | .380 | .420 | |
| E1 | 6.22 | - | .245 | - | |
| e | 2.54 BSC | | .100 BSC | | |
| H | 14.61 | 15.88 | .575 | .625 | |
| L | 1.78 | 2.79 | .070 | .110 | |
| L1 | - | 1.65 | - | .066 | |
| L2 | 1.27 | 1.78 | - | .070 | |
| L3 | 0.25 BSC | | .010 BSC | | |
| L4 | 4.78 | 5.28 | .188 | .208 | |

LEAD ASSIGNMENTS

- DIODES
 1.- ANODE (TWO DIE) / OPEN (ONE DIE)
 2.- CATHODE
 3.- ANODE
- HEXFET
 1.- GATE
 2.- DRAIN
 3.- SOURCE
- IGBTs, CoPACK
 1.- GATE
 2.- COLLECTOR
 3.- EMITTER

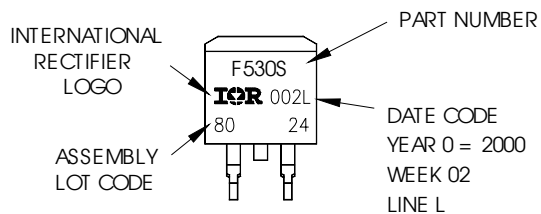


NOTES:

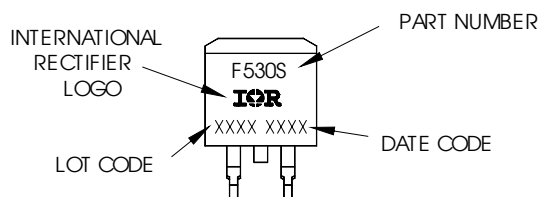
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
7. CONTROLLING DIMENSION: INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263AB.

D²Pak Part Marking Information

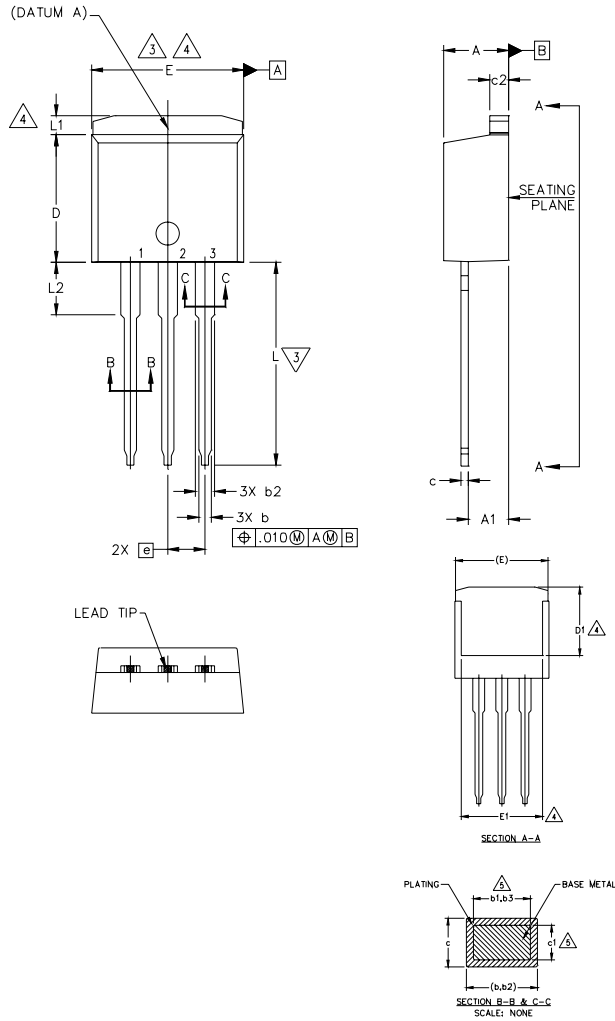
EXAMPLE: THIS IS AN IRF530S WITH
 LOT CODE 8024
 ASSEMBLED ON WW02, 2000
 IN THE ASSEMBLY LINE "L"



EXAMPLE: THIS IS AN IRF530S WITH
 LOT CODE 8024
 For GB Production
 ASSEMBLED ON WW02, 2000
 IN THE ASSEMBLY LINE "L"



TO-262 Package Outline (Dimensions are shown in millimeters (inches))



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. CONTROLLING DIMENSION: INCH.
7. OUTLINE CONFORM TO JEDEC TO-262 EXCEPT A1(max.), b(min.) AND D1(min.) WHERE DIMENSIONS DERIVED THE ACTUAL PACKAGE OUTLINE.

| SYMBOL | DIMENSIONS | | | | NOTES |
|--------|-------------|-------|----------|------|-------|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | |
| A1 | 2.03 | 3.02 | .080 | .119 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | 5 |
| b2 | 1.14 | 1.78 | .045 | .070 | |
| b3 | 1.14 | 1.73 | .045 | .068 | 5 |
| c | 0.38 | 0.74 | .015 | .029 | |
| c1 | 0.38 | 0.58 | .015 | .023 | 5 |
| c2 | 1.14 | 1.65 | .045 | .065 | |
| D | 8.38 | 9.65 | .330 | .380 | 3 |
| D1 | 6.86 | - | .270 | - | 4 |
| E | 9.65 | 10.67 | .380 | .420 | 3, 4 |
| E1 | 6.22 | - | .245 | - | 4 |
| e | 2.54 BSC | | .100 BSC | | |
| L | 13.46 | 14.10 | .530 | .555 | |
| L1 | - | 1.65 | - | .065 | 4 |
| L2 | 3.56 | 3.71 | .140 | .146 | |

LEAD ASSIGNMENTS

HEXFET

- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

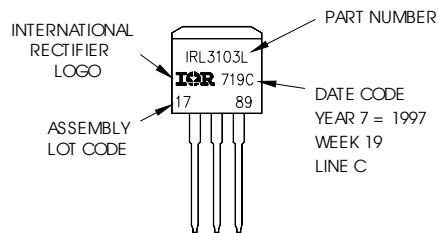
IGBTs, CoPACK

- 1.- GATE
- 2.- COLLECTOR
- 3.- EMITTER
- 4.- COLLECTOR

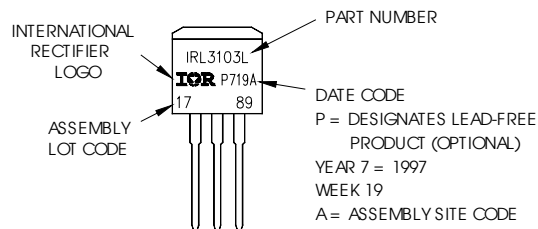
TO-262 Part Marking Infor

EXAMPLE: THIS IS AN IRL3103L
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"

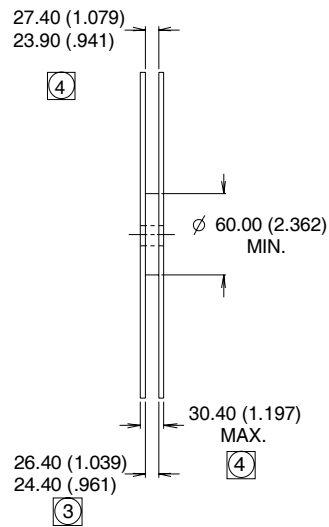
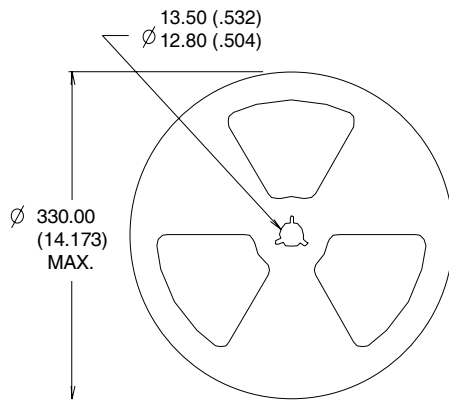
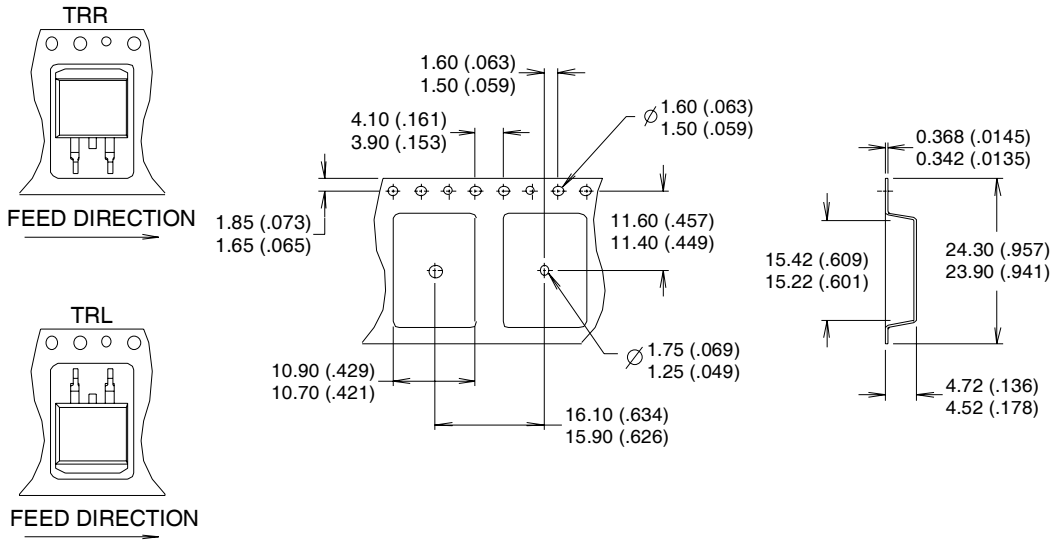
Note: "P" in assembly line position indicates "Lead - Free"



OR



D²Pak Tape & Reel Information



- NOTES:
1. COMFORMS TO EIA-418.
 2. CONTROLLING DIMENSION: MILLIMETER.
 - ③ DIMENSION MEASURED @ HUB.
 - ④ INCLUDES FLANGE DISTORTION @ OUTER EDGE.

Data and specifications subject to change without notice.
This product has been designed and qualified for the Industrial market.
Qualification Standards can be found on IR's Web site.

IMPORTANT NOTICE

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffheitsgarantie").

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WARNINGS

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