

# IRFS5615PbF

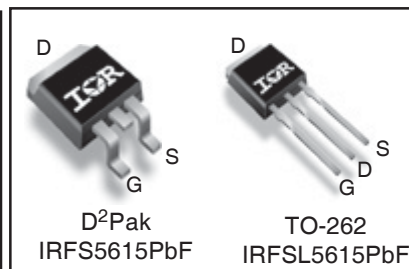
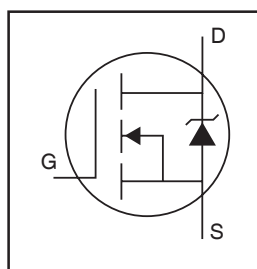
## IRFSL5615PbF

### Features

- Key Parameters Optimized for Class-D Audio Amplifier Applications
- Low  $R_{DS(ON)}$  for Improved Efficiency
- Low  $Q_G$  and  $Q_{SW}$  for Better THD and Improved Efficiency
- Low  $Q_{RR}$  for Better THD and Lower EMI
- 175°C Operating Junction Temperature for Ruggedness
- Can Deliver up to 300W per Channel into 4Ω Load in Half-Bridge Configuration Amplifier

### Key Parameters

|                         |      |    |
|-------------------------|------|----|
| $V_{DS}$                | 150  | V  |
| $R_{DS(ON)}$ typ. @ 10V | 34.5 | mΩ |
| $Q_g$ typ.              | 26   | nC |
| $Q_{sw}$ typ.           | 11   | nC |
| $R_{G(int)}$ typ.       | 2.7  | Ω  |
| $T_J$ max               | 175  | °C |



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

### Description

This Digital Audio MOSFET is specifically designed for Class-D audio amplifier applications. This MOSFET utilizes the latest processing techniques to achieve low on-resistance per silicon area. Furthermore, Gate charge, body-diode reverse recovery and internal Gate resistance are optimized to improve key Class-D audio amplifier performance factors such as efficiency, THD and EMI. Additional features of this MOSFET are 175°C operating junction temperature and repetitive avalanche capability. These features combine to make this MOSFET a highly efficient, robust and reliable device for ClassD audio amplifier applications.

### Absolute Maximum Ratings

|                                   | Parameter                                                  | Max.         | Units |
|-----------------------------------|------------------------------------------------------------|--------------|-------|
| $V_{DS}$                          | Drain-to-Source Voltage                                    | 150          | V     |
| $V_{GS}$                          | Gate-to-Source Voltage                                     | ±20          |       |
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V                   | 33           | A     |
| $I_D$ @ $T_C = 100^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V                   | 24           |       |
| $I_{DM}$                          | Pulsed Drain Current ①                                     | 140          | W     |
| $P_D$ @ $T_C = 25^\circ\text{C}$  | Power Dissipation ④                                        | 144          |       |
| $P_D$ @ $T_C = 100^\circ\text{C}$ | Power Dissipation ④                                        | 72           |       |
|                                   | Linear Derating Factor                                     | 0.96         | W/°C  |
| $T_J$<br>$T_{STG}$                | Operating Junction and<br>Storage Temperature Range        | -55 to + 175 | °C    |
|                                   | Soldering Temperature, for 10 seconds<br>(1.6mm from case) | 300          |       |

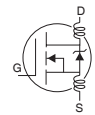
### Thermal Resistance

|                 | Parameter                         | Typ. | Max.  | Units |
|-----------------|-----------------------------------|------|-------|-------|
| $R_{\theta JC}$ | Junction-to-Case ④                | —    | 1.045 | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount) ⑥ | —    | 40    |       |

Notes ① through ⑥ are on page 2

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

|                                | Parameter                            | Min. | Typ. | Max. | Units                | Conditions                                                                                        |
|--------------------------------|--------------------------------------|------|------|------|----------------------|---------------------------------------------------------------------------------------------------|
| $BV_{DSS}$                     | Drain-to-Source Breakdown Voltage    | 150  | —    | —    | V                    | $V_{GS} = 0V, I_D = 250\mu A$                                                                     |
| $\Delta BV_{DSS}/\Delta T_J$   | Breakdown Voltage Temp. Coefficient  | —    | 0.18 | —    | V/ $^\circ\text{C}$  | Reference to $25^\circ\text{C}$ , $I_D = 1mA$                                                     |
| $R_{DS(on)}$                   | Static Drain-to-Source On-Resistance | —    | 34.5 | 42   | m $\Omega$           | $V_{GS} = 10V, I_D = 21A$ ③                                                                       |
| $V_{GS(th)}$                   | Gate Threshold Voltage               | 3.0  | —    | 5.0  | V                    | $V_{DS} = V_{GS}, I_D = 100\mu A$                                                                 |
| $\Delta V_{GS(th)}/\Delta T_J$ | Gate Threshold Voltage Coefficient   | —    | -13  | —    | mV/ $^\circ\text{C}$ |                                                                                                   |
| $I_{DSS}$                      | Drain-to-Source Leakage Current      | —    | —    | 20   | $\mu A$              | $V_{DS} = 150V, V_{GS} = 0V$                                                                      |
|                                |                                      | —    | —    | 250  |                      | $V_{DS} = 150V, V_{GS} = 0V, T_J = 125^\circ\text{C}$                                             |
| $I_{GSS}$                      | Gate-to-Source Forward Leakage       | —    | —    | 100  | nA                   | $V_{GS} = 20V$                                                                                    |
|                                | Gate-to-Source Reverse Leakage       | —    | —    | -100 |                      | $V_{GS} = -20V$                                                                                   |
| $g_{fs}$                       | Forward Transconductance             | 35   | —    | —    | S                    | $V_{DS} = 50V, I_D = 21A$                                                                         |
| $Q_g$                          | Total Gate Charge                    | —    | 26   | 40   | nC                   | $V_{DS} = 75V$<br>$V_{GS} = 10V$<br>$I_D = 21A$<br>See Fig. 6 and 19                              |
| $Q_{gs1}$                      | Pre-Vth Gate-to-Source Charge        | —    | 6.4  | —    |                      |                                                                                                   |
| $Q_{gs2}$                      | Post-Vth Gate-to-Source Charge       | —    | 2.2  | —    |                      |                                                                                                   |
| $Q_{gd}$                       | Gate-to-Drain Charge                 | —    | 9.0  | —    |                      |                                                                                                   |
| $Q_{godr}$                     | Gate Charge Overdrive                | —    | 8.9  | —    |                      |                                                                                                   |
| $Q_{sw}$                       | Switch Charge ( $Q_{gs2} + Q_{gd}$ ) | —    | 11   | —    |                      |                                                                                                   |
| $R_{G(int)}$                   | Internal Gate Resistance             | —    | 2.7  | 5.0  | $\Omega$             |                                                                                                   |
| $t_{d(on)}$                    | Turn-On Delay Time                   | —    | 8.9  | —    | ns                   | $V_{DD} = 75V, V_{GS} = 10V$ ③<br>$I_D = 21A$<br>$R_G = 2.4\Omega$                                |
| $t_r$                          | Rise Time                            | —    | 23.1 | —    |                      |                                                                                                   |
| $t_{d(off)}$                   | Turn-Off Delay Time                  | —    | 17.2 | —    |                      |                                                                                                   |
| $t_f$                          | Fall Time                            | —    | 13.1 | —    |                      |                                                                                                   |
| $C_{iss}$                      | Input Capacitance                    | —    | 1750 | —    | pF                   | $V_{GS} = 0V$<br>$V_{DS} = 50V$<br>$f = 1.0MHz$ , See Fig.5<br>$V_{GS} = 0V, V_{DS} = 0V$ to 120V |
| $C_{oss}$                      | Output Capacitance                   | —    | 155  | —    |                      |                                                                                                   |
| $C_{rss}$                      | Reverse Transfer Capacitance         | —    | 40   | —    |                      |                                                                                                   |
| $C_{oss}$                      | Effective Output Capacitance         | —    | 175  | —    |                      |                                                                                                   |
| $L_D$                          | Internal Drain Inductance            | —    | 4.5  | —    | nH                   | Between lead,<br>6mm (0.25in.)<br>from package<br>and center of die contact                       |
| $L_S$                          | Internal Source Inductance           | —    | 7.5  | —    |                      |                                                                                                   |

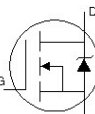


## Avalanche Characteristics

|          | Parameter                       | Typ.                      | Max. | Units |
|----------|---------------------------------|---------------------------|------|-------|
| $E_{AS}$ | Single Pulse Avalanche Energy ② | —                         | 109  | mJ    |
| $I_{AR}$ | Avalanche Current ⑤             | See Fig. 14, 15, 17a, 17b |      | A     |
| $E_{AR}$ | Repetitive Avalanche Energy ⑤   |                           |      | mJ    |

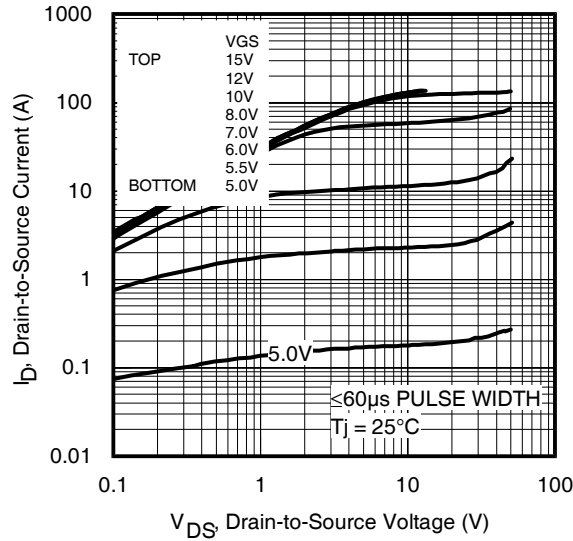
## Diode Characteristics

|                                | Parameter                                 | Min. | Typ. | Max. | Units | Conditions                                                                |
|--------------------------------|-------------------------------------------|------|------|------|-------|---------------------------------------------------------------------------|
| $I_S @ T_C = 25^\circ\text{C}$ | Continuous Source Current<br>(Body Diode) | —    | —    | 33   | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode.   |
| $I_{SM}$                       | Pulsed Source Current<br>(Body Diode) ①   | —    | —    | 140  |       |                                                                           |
| $V_{SD}$                       | Diode Forward Voltage                     | —    | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 21A, V_{GS} = 0V$ ③                        |
| $t_{rr}$                       | Reverse Recovery Time                     | —    | 80   | 120  | ns    | $T_J = 25^\circ\text{C}, I_F = 21A, V_R = 120V$<br>$di/dt = 100A/\mu s$ ③ |
| $Q_{rr}$                       | Reverse Recovery Charge                   | —    | 312  | 468  | nC    |                                                                           |

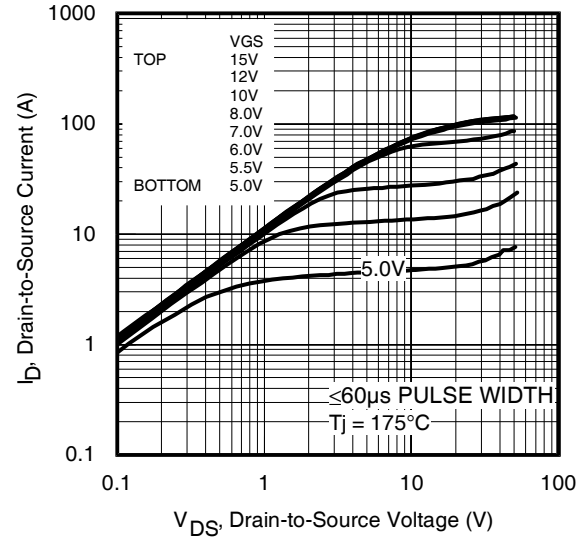


### Notes:

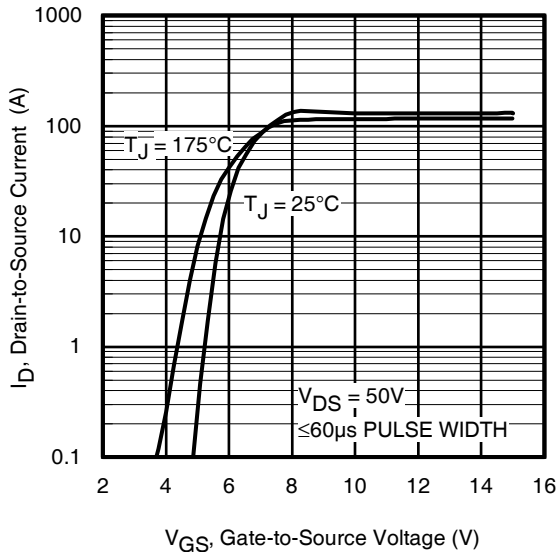
- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.51mH$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 21A$ .
- ③ Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .
- ④  $R_G$  is measured at  $T_J$  of approximately  $90^\circ\text{C}$ .
- ⑤ Limited by  $T_{Jmax}$ . See Figs. 14, 15, 17a, 17b for repetitive avalanche information
- ⑥ When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.



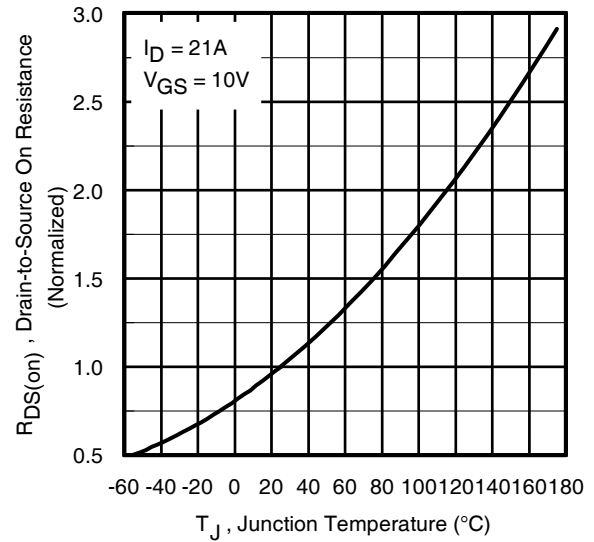
**Fig 1.** Typical Output Characteristics



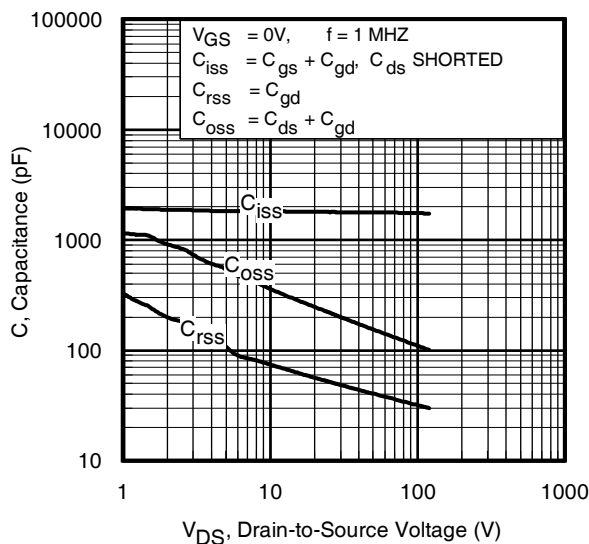
**Fig 2.** Typical Output Characteristics



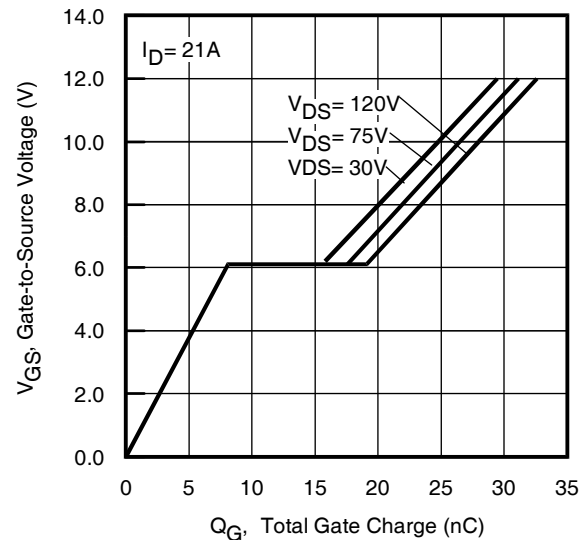
**Fig 3.** Typical Transfer Characteristics



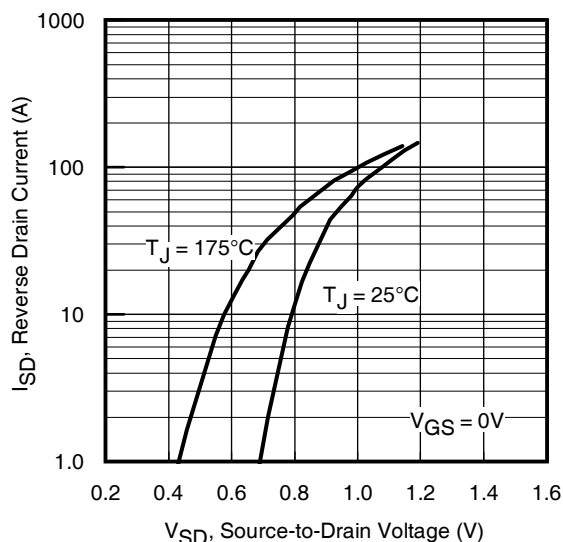
**Fig 4.** Normalized On-Resistance vs. Temperature



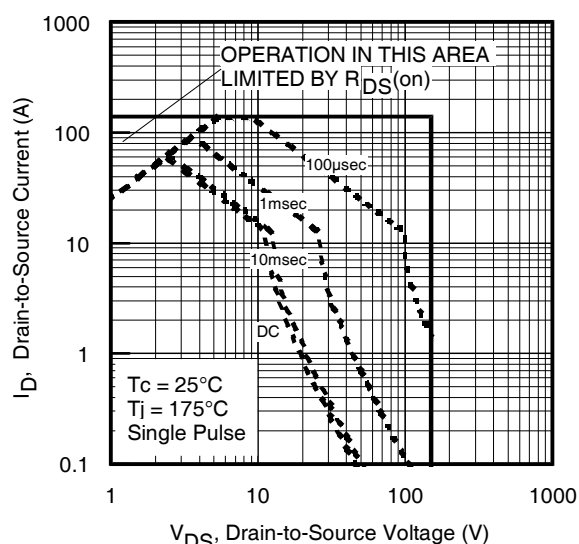
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage  
[www.irf.com](http://www.irf.com)



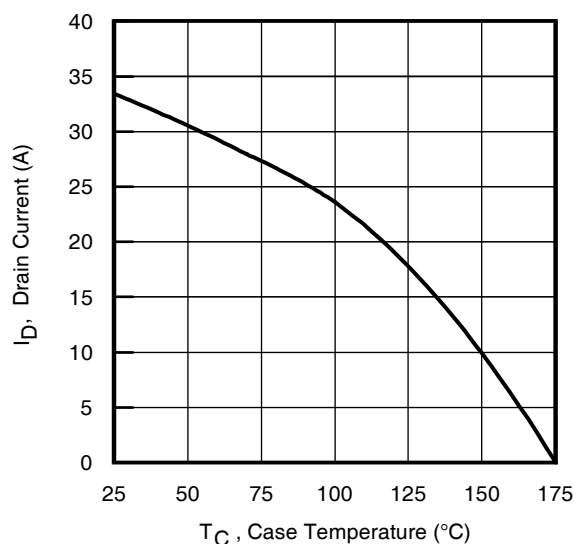
**Fig 6.** Typical Gate Charge vs. Gate-to-Source Voltage



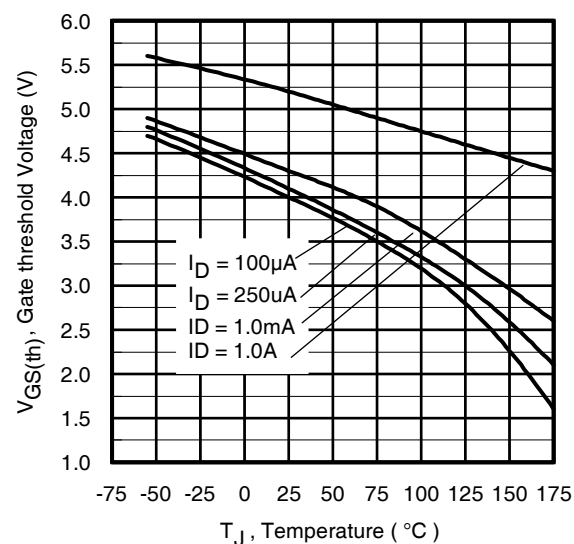
**Fig 7.** Typical Source-Drain Diode Forward Voltage



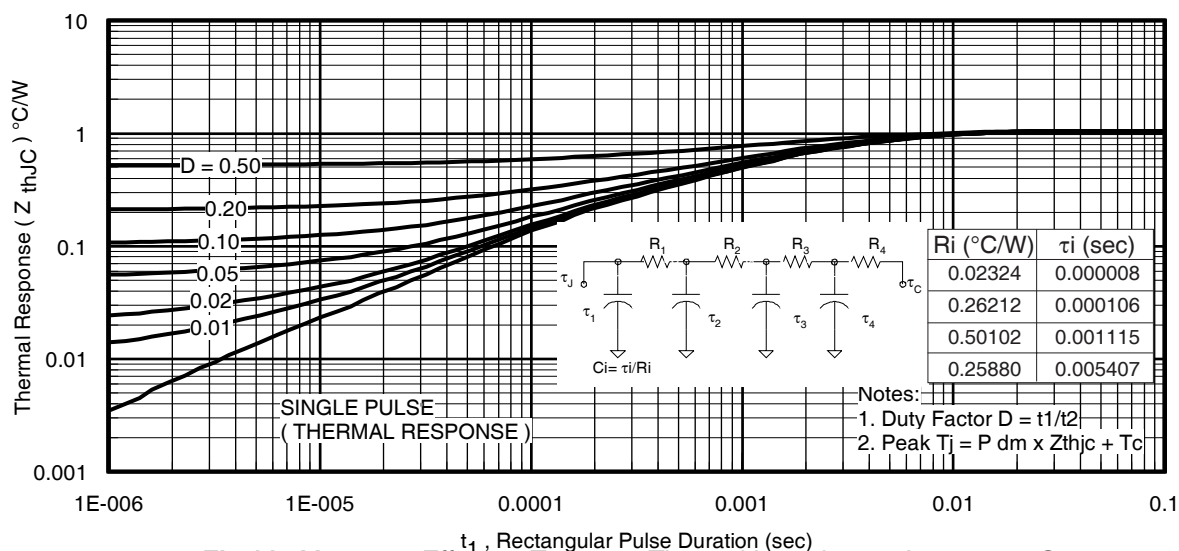
**Fig 8.** Maximum Safe Operating Area



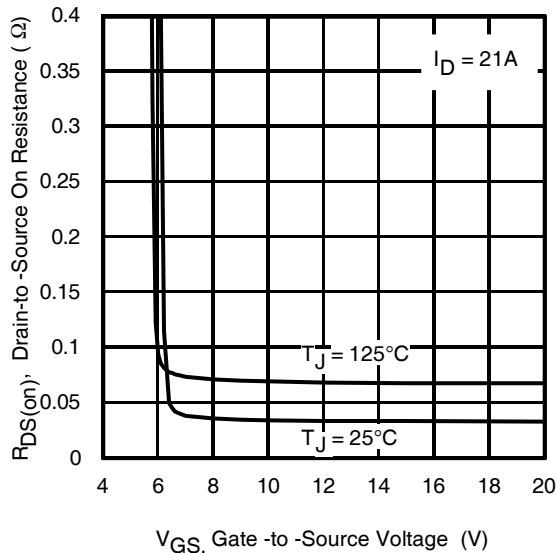
**Fig 9.** Maximum Drain Current vs. Case Temperature



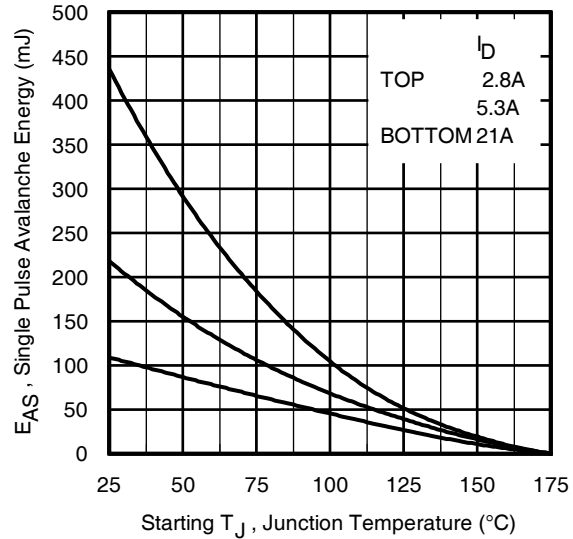
**Fig 10.** Threshold Voltage vs. Temperature



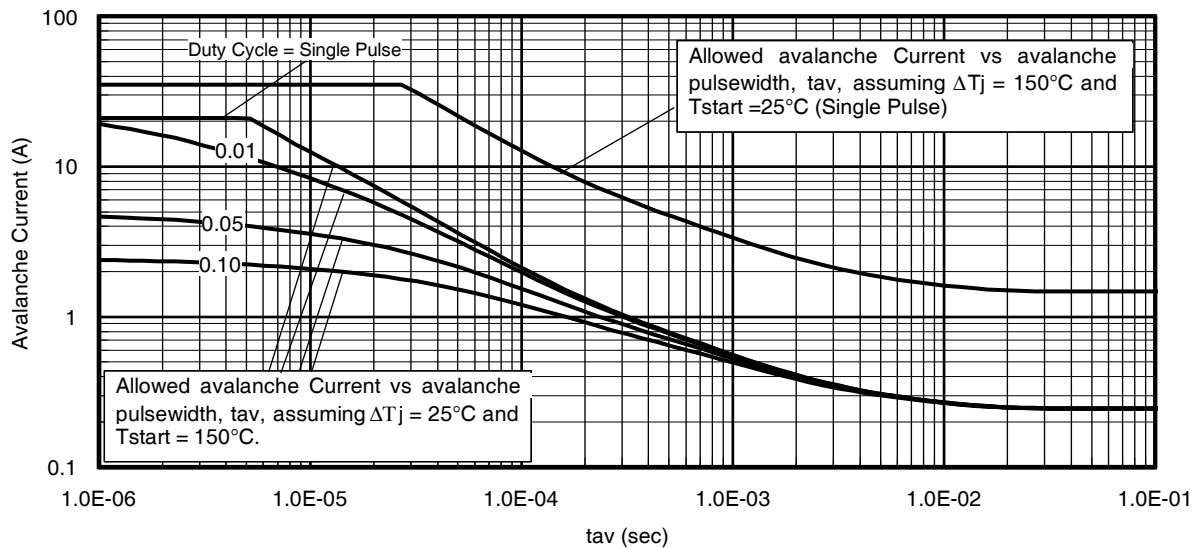
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case



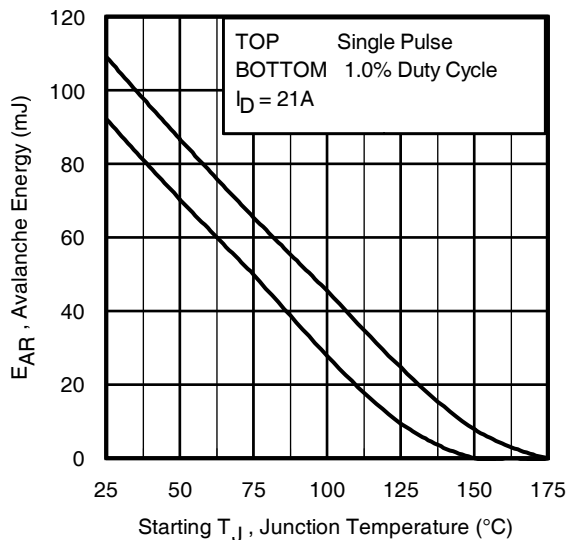
**Fig 12.** On-Resistance Vs. Gate Voltage



**Fig 13.** Maximum Avalanche Energy Vs. Drain Current



**Fig 14.** Typical Avalanche Current Vs. Pulsewidth



**Fig 15.** Maximum Avalanche Energy Vs. Temperature

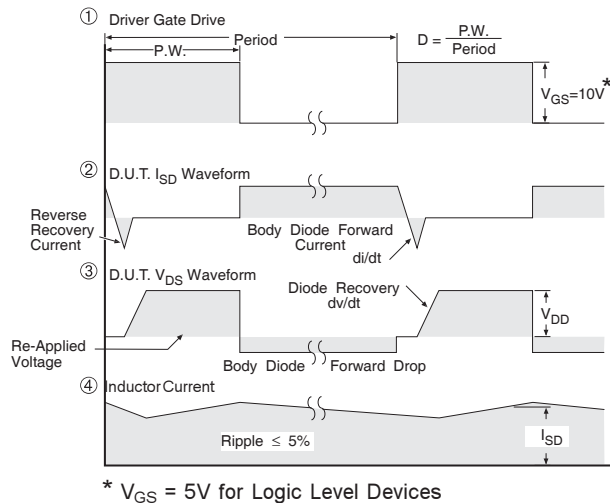
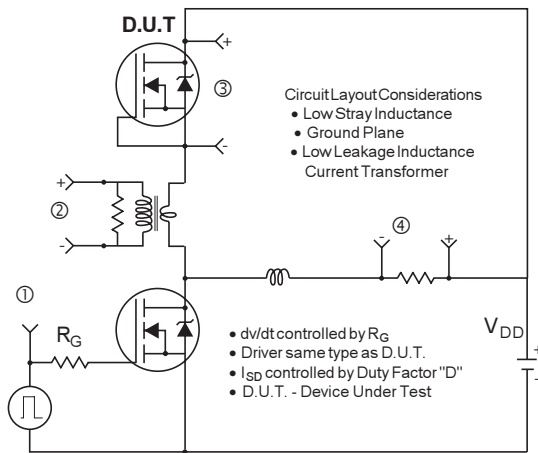
**Notes on Repetitive Avalanche Curves , Figures 14, 15:**  
(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

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 neither  $T_{jmax}$  nor  $I_{av}$  (max) is exceeded
3. Equation below based on circuit and waveforms shown in Figures 17a, 17b.
4.  $P_{D(ave)}$  = Average power dissipation per single avalanche pulse.
5.  $B_V$  = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6.  $I_{av}$  = Allowable avalanche current.
7.  $\Delta T$  = 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 figure 11)

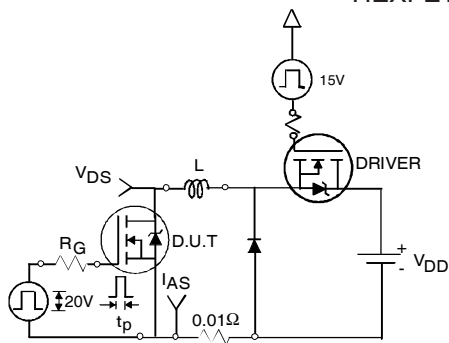
$$P_{D(ave)} = \frac{1}{2} (1.3 \cdot B_V \cdot I_{av}) = \Delta T / Z_{thJC}$$

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

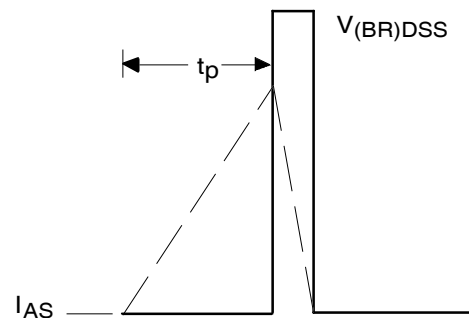
$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$



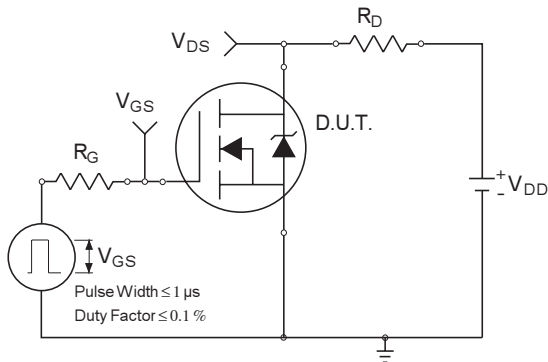
**Fig 16. Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs**



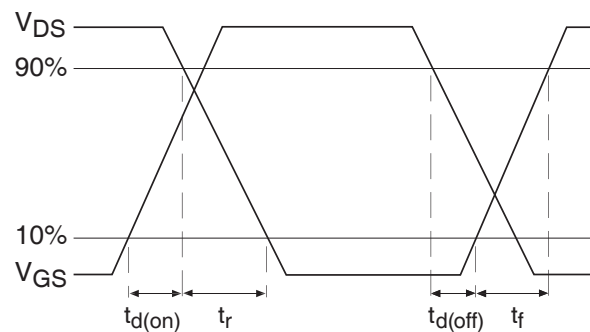
**Fig 17a. Unclamped Inductive Test Circuit**



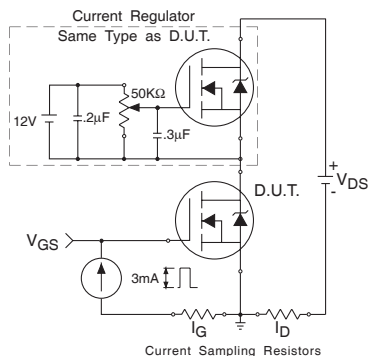
**Fig 17b. Unclamped Inductive Waveforms**



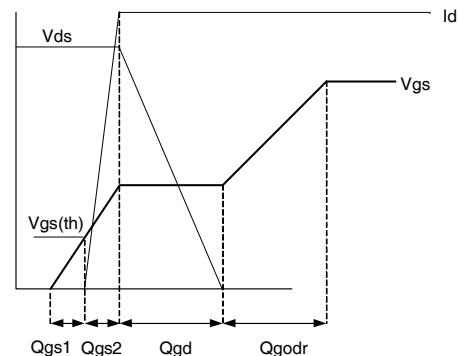
**Fig 18a. Switching Time Test Circuit**



**Fig 18b. Switching Time Waveforms**



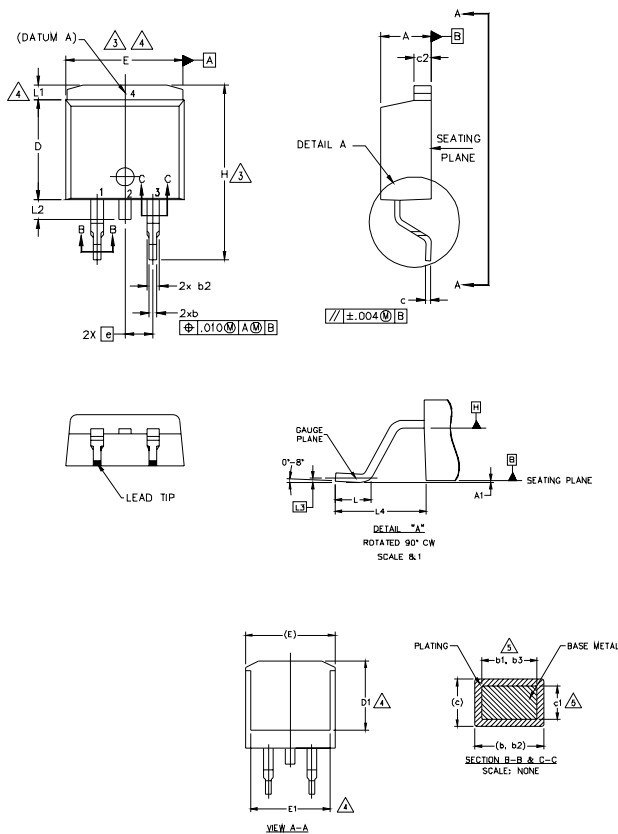
**Fig 19a. Gate Charge Test Circuit**



**Fig 19b. Gate Charge Waveform**

## D<sup>2</sup>Pak (TO-263AB) 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 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.

| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 4.06        | 4.83  | .160     | .190 |       |
| A1     | 0.00        | 0.254 | .000     | .010 |       |
| 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 |      |       |
| H      | 14.61       | 15.88 | .575     | .625 |       |
| L      | 1.78        | 2.79  | .070     | .110 |       |
| L1     | —           | 1.65  | —        | .066 | 4     |
| L2     | 1.27        | 1.78  | —        | .070 |       |
| L3     | 0.25 BSC    |       | .010 BSC |      |       |
| L4     | 4.78        | 5.28  | .188     | .208 |       |

### LEAD ASSIGNMENTS

#### HEXFET

1. GATE
2. DRAIN
3. SOURCE

#### IGBTs, CoPACK

1. GATE
2. COLLECTOR
3. EMITTER

#### DIODES

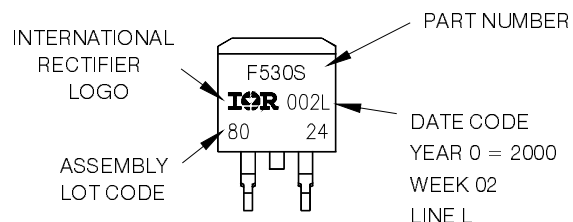
1. ANODE \*
2. CATHODE
3. ANODE

\* PART DEPENDENT.

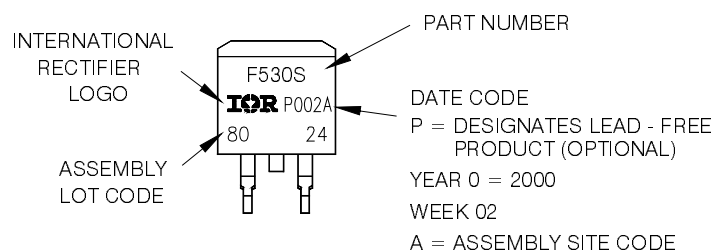
## D<sup>2</sup>Pak (TO-263AB) Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH  
LOT CODE 8024  
ASSEMBLED ON WW 02, 2000  
IN THE ASSEMBLY LINE "L"

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



OR



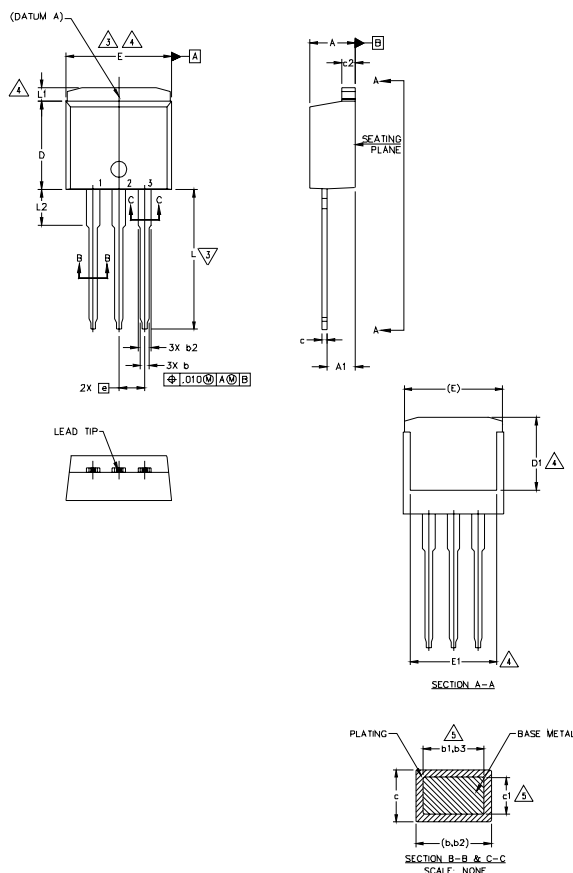
Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

[www.irf.com](http://www.irf.com)

# IRFS/SL5615PbF

## 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

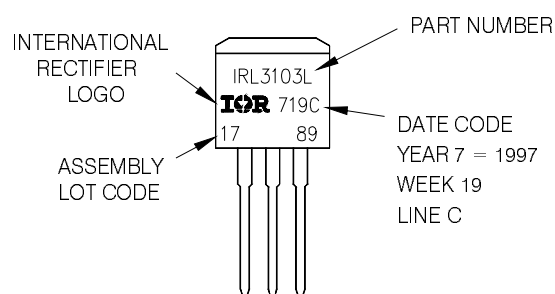
#### IGBTs, CoPACK

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

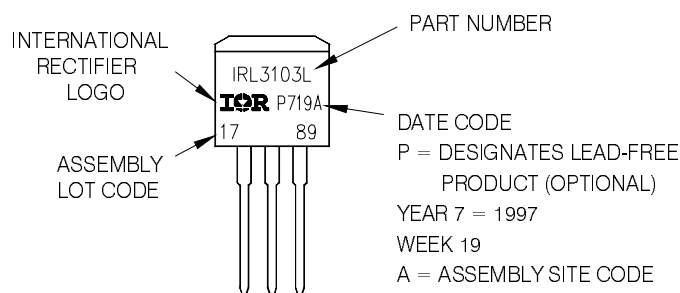
## TO-262 Part Marking Information

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"



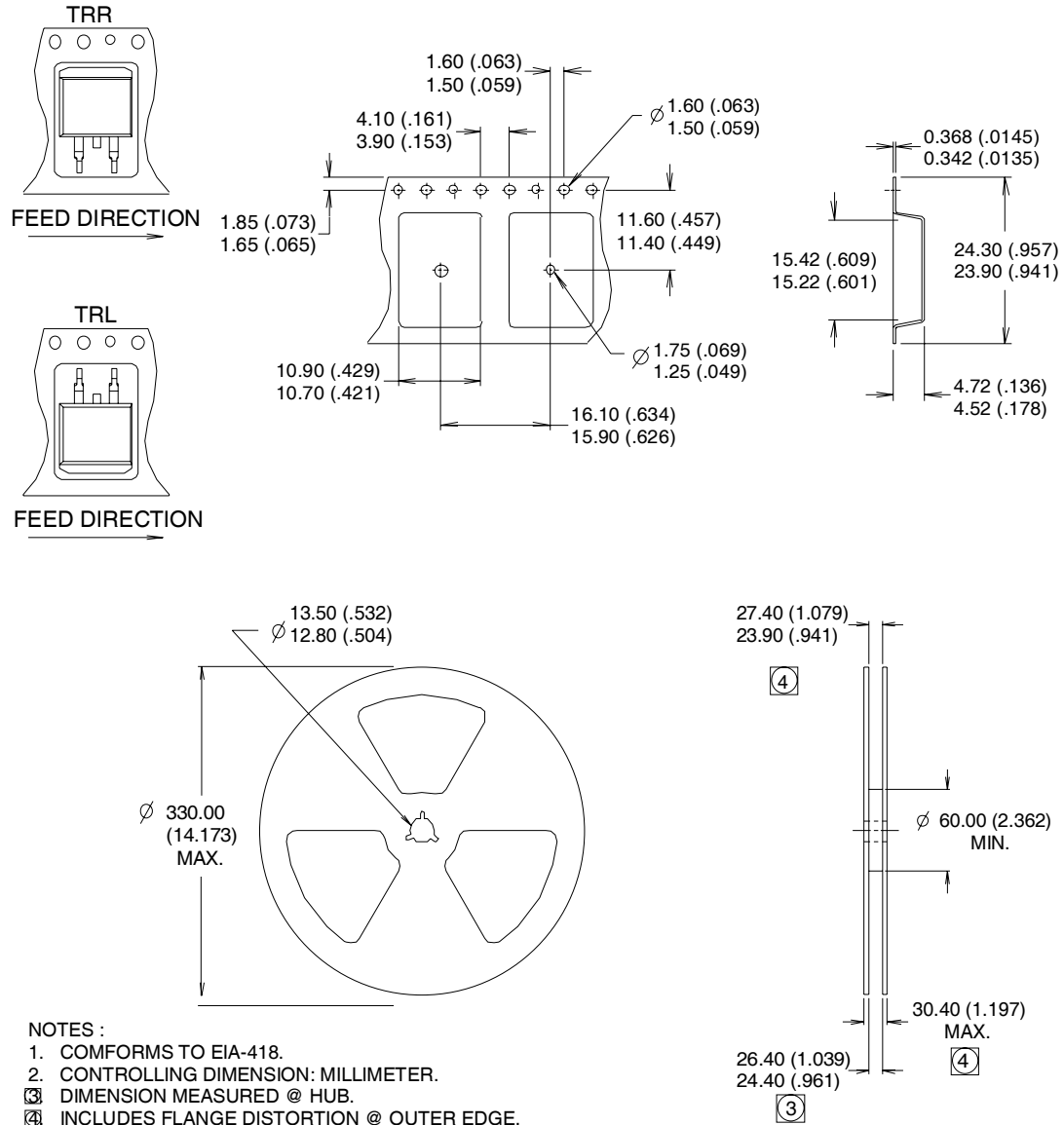
OR



Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

## D<sup>2</sup>Pak (TO-263AB) Tape & Reel Information

Dimensions are shown in millimeters (inches)



**Note:** For the most current drawing please refer to IR website at <http://www.irf.com/package/>

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.

International  
**IR** Rectifier

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