International
IOR Rectifier

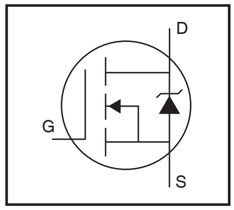
**AUTOMOTIVE GRADE**

# AUIRFZ48Z
# AUIRFZ48ZS

HEXFET® Power MOSFET

### Features

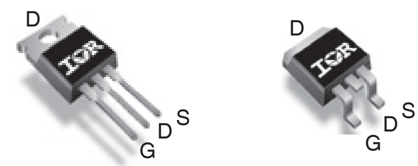
- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to Tjmax
- Lead-Free, RoHS Compliant
- Automotive Qualified *




| | |
|---|---|
| $V_{(BR)DSS}$ | 55V |
| $R_{DS(on)}$ max. | 11mΩ |
| $I_D$ | 61A |

### Description

Specifically designed for Automotive applications, this HEXFET® Power MOSFET utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this design are a 175°C junction operating temperature, fast switching speed and improved repetitive avalanche rating . These features combine to make this design an extremely efficient and reliable device for use in Automotive applications and a wide variety of other applications.




TO-220AB AUIRFZ48Z

$D^2$Pak AUIRFZ48ZS

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

### Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; and functional operation of the device at these or any other condition beyond those indicated in the specifications is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions. Ambient temperature ($T_A$) is 25°C, unless otherwise specified.

| | Parameter | Max. | Units |
|---|---|---|---|
| $I_D$ @ $T_C$ = 25°C | Continuous Drain Current, $V_{GS}$ @ 10V | 61 | A |
| $I_D$ @ $T_C$ = 100°C | Continuous Drain Current, $V_{GS}$ @ 10V | 43 | |
| $I_{DM}$ | Pulsed Drain Current ① | 240 | |
| $P_D$ @$T_C$ = 25°C | Maximum Power Dissipation | 91 | W |
| | Linear Derating Factor | 0.61 | W/°C |
| $V_{GS}$ | Gate-to-Source Voltage | ± 20 | V |
| $E_{AS}$ | Single Pulse Avalanche Energy (Thermally Limited) ② | 73 | mJ |
| $E_{AS}$ (tested) | Single Pulse Avalanche Energy Tested Value ⑦ | 120 | |
| $I_{AR}$ | Avalanche Current ① | See Fig.12a,12b,15,16 | A |
| $E_{AR}$ | Repetitive Avalanche Energy ⑥ | | mJ |
| dv/dt | Peak Diode Recovery dv/dt ③ | 7.2 | V/ns |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to + 175 | °C |
| | Soldering Temperature, for 10 seconds (1.6mm from case ) | 300 | |
| | Mounting torque, 6-32 or M3 screw | 10 lbf•in (1.1N•m) | |

### Thermal Resistance

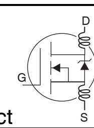
| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case ⑨ | ––– | 1.64 | °C/W |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface | 0.50 | ––– | |
| $R_{\theta JA}$ | Junction-to-Ambient | ––– | 62 | |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount, steady state)⑧ | ––– | 40 | |

HEXFET® is a registered trademark of International Rectifier.
*Qualification standards can be found at http://www.irf.com/

## Static Electrical Characteristics @ $T_J$ = 25°C (unless otherwise specified)

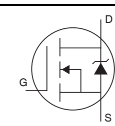
| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-to-Source Breakdown Voltage | 55 | ––– | ––– | V | $V_{GS}$ = 0V, $I_D$ = 250μA |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | ––– | 0.054 | ––– | V/°C | Reference to 25°C, $I_D$ = 1mA |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | ––– | 8.6 | 11 | mΩ | $V_{GS}$ = 10V, $I_D$ = 37A ④ |
| $V_{GS(th)}$ | Gate Threshold Voltage | 2.0 | ––– | 4.0 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 250μA |
| gfs | Forward Transconductance | 24 | ––– | ––– | S | $V_{DS}$ = 25V, $I_D$ = 37A |
| $I_{DSS}$ | Drain-to-Source Leakage Current | ––– | ––– | 20 | μA | $V_{DS}$ = 55V, $V_{GS}$ = 0V |
| | | ––– | ––– | 250 | | $V_{DS}$ = 55V, $V_{GS}$ = 0V, $T_J$ = 125°C |
| $I_{GSS}$ | Gate-to-Source Forward Leakage | ––– | ––– | 200 | nA | $V_{GS}$ = 20V |
| | Gate-to-Source Reverse Leakage | ––– | ––– | -200 | | $V_{GS}$ = -20V |

## Dynamic Electrical Characteristics @ $T_J$ = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate Charge | ––– | 43 | 64 | nC | $I_D$ = 37A |
| $Q_{gs}$ | Gate-to-Source Charge | ––– | 11 | 16 | | $V_{DS}$ = 44V |
| $Q_{gd}$ | Gate-to-Drain ("Miller") Charge | ––– | 16 | 24 | | $V_{GS}$ = 10V ④ |
| $t_{d(on)}$ | Turn-On Delay Time | ––– | 15 | ––– | ns | $V_{DD}$ = 28V |
| $t_r$ | Rise Time | ––– | 69 | ––– | | $I_D$ = 37A |
| $t_{d(off)}$ | Turn-Off Delay Time | ––– | 35 | ––– | | $R_G$ = 12Ω |
| $t_f$ | Fall Time | ––– | 39 | ––– | | $V_{GS}$ = 10V ④ |
| $L_D$ | Internal Drain Inductance | ––– | 4.5 | ––– | nH | Between lead, 6mm (0.25in.) from package and center of die contact  |
| $L_S$ | Internal Source Inductance | ––– | 7.5 | ––– | | |
| $C_{iss}$ | Input Capacitance | ––– | 1720 | ––– | pF | $V_{GS}$ = 0V |
| $C_{oss}$ | Output Capacitance | ––– | 300 | ––– | | $V_{DS}$ = 25V |
| $C_{rss}$ | Reverse Transfer Capacitance | ––– | 160 | ––– | | ƒ = 1.0MHz, See Fig. 5 |
| $C_{oss}$ | Output Capacitance | ––– | 1020 | ––– | | $V_{GS}$ = 0V, $V_{DS}$ = 1.0V, ƒ = 1.0MHz |
| $C_{oss}$ | Output Capacitance | ––– | 230 | ––– | | $V_{GS}$ = 0V, $V_{DS}$ = 44V, ƒ = 1.0MHz |
| $C_{oss}$ eff. | Effective Output Capacitance | ––– | 380 | ––– | | $V_{GS}$ = 0V, $V_{DS}$ = 0V to 44V |



## Diode Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current (Body Diode) | ––– | ––– | 61 | A | MOSFET symbol showing the integral reverse p-n junction diode.  |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ① | ––– | ––– | 240 | | |
| $V_{SD}$ | Diode Forward Voltage | ––– | ––– | 1.3 | V | $T_J$ = 25°C, $I_S$ = 37A, $V_{GS}$ = 0V ④ |
| $t_{rr}$ | Reverse Recovery Time | ––– | 20 | 31 | ns | $T_J$ = 25°C, $I_F$ = 37A, $V_{DD}$ = 30V |
| $Q_{rr}$ | Reverse Recovery Charge | ––– | 13 | 20 | nC | di/dt = 100A/μs ④ |
| $t_{on}$ | Forward Turn-On Time | Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD) | | | | |



**Notes:**

① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).

② Limited by $T_{Jmax}$, starting $T_J$ = 25°C, L =0.11mH, $R_G$ = 25Ω, $I_{AS}$ = 37A, $V_{GS}$ =10V. Part not recommended for use above this value.

③ $I_{SD} \leq$ 37A, di/dt ≤ 920A/μs, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq$ 175°C.

④ Pulse width ≤ 1.0ms; duty cycle ≤ 2%.

⑤ $C_{oss}$ eff. is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{DSS}$ .

⑥ Limited by $T_{Jmax}$ , see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.

⑦ This value determined from sample failure population, starting $T_J$ = 25°C, L =0.11mH, $R_G$ = 25Ω, $I_{AS}$ = 37A, $V_{GS}$ =10V.

⑧ This is applied to $D^2$Pak, when mounted on 1" square PCB ( FR-4 or G-10 Material ). For recommended footprint and soldering techniques refer to application note #AN-994.

⑨ $R_\theta$ is rated at $T_J$ of approximately 90°C.

**Qualification Information†**

<table>
<tr><td rowspan="2" colspan="2">Qualification Level</td><td colspan="2">Automotive<br>(per AEC-Q101) ††</td></tr>
<tr><td colspan="2">Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.</td></tr>
<tr><td rowspan="2" colspan="2">Moisture Sensitivity Level</td><td>TO-220AB</td><td>N/A</td></tr>
<tr><td>D²Pak</td><td>MSL1</td></tr>
<tr><td rowspan="3">ESD</td><td>Machine Model</td><td colspan="2">Class M4 (+/- 425V)†††<br>AEC-Q101-002</td></tr>
<tr><td>Human Body Model</td><td colspan="2">Class H1B (+/- 1000V)†††<br>AEC-Q101-001</td></tr>
<tr><td>Charged Device Model</td><td colspan="2">Class C5 (+/- 1125V)†††<br>AEC-Q101-005</td></tr>
<tr><td colspan="2">RoHS Compliant</td><td colspan="2">Yes</td></tr>
</table>

† Qualification standards can be found at International Rectifier's web site: http//www.irf.com/

†† Exceptions to AEC-Q101 requirements are noted in the qualification report.

††† Highest passing voltage.

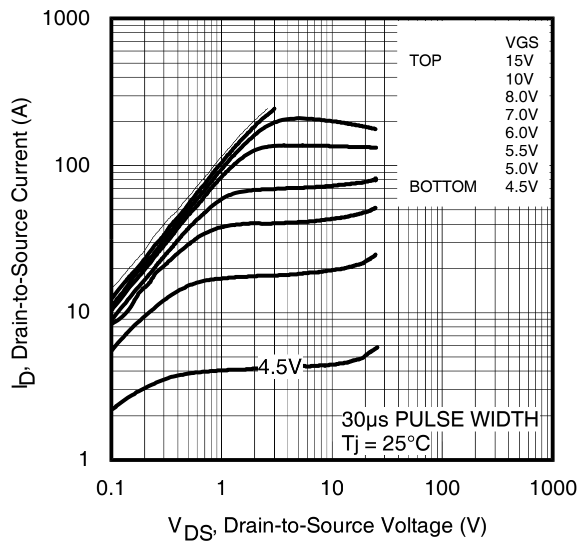



**Fig 1.** Typical Output Characteristics

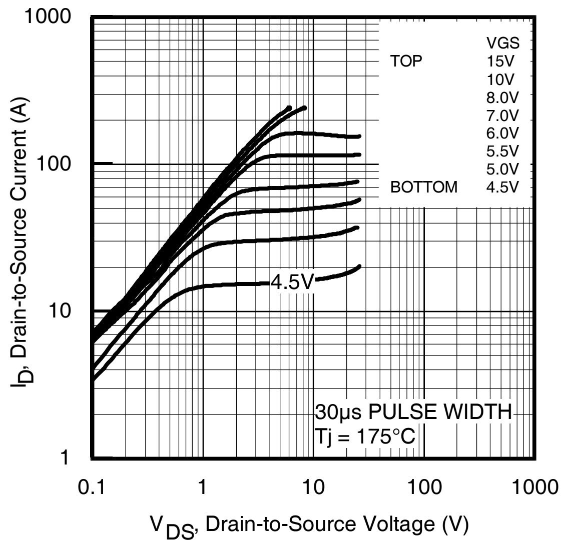



**Fig 2.** Typical Output Characteristics

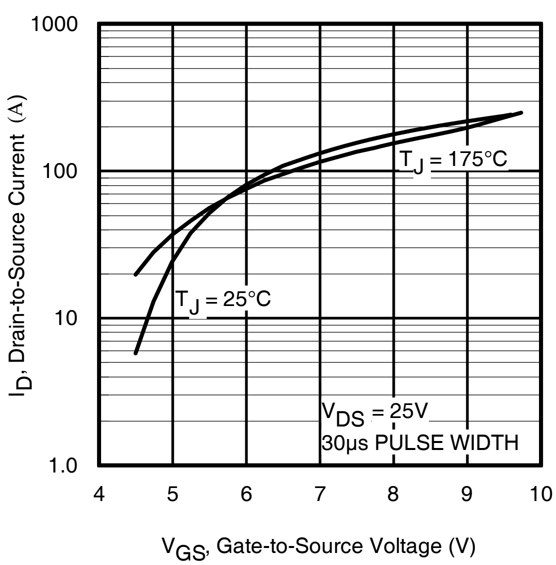



**Fig 3.** Typical Transfer Characteristics

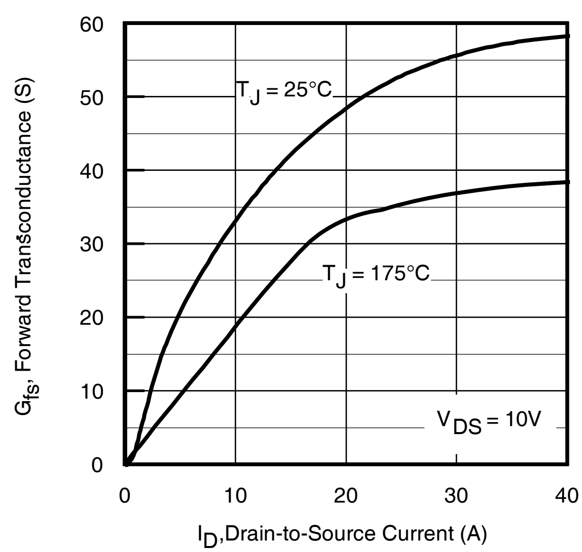



**Fig 4.** Typical Forward Transconductance vs. Drain Current

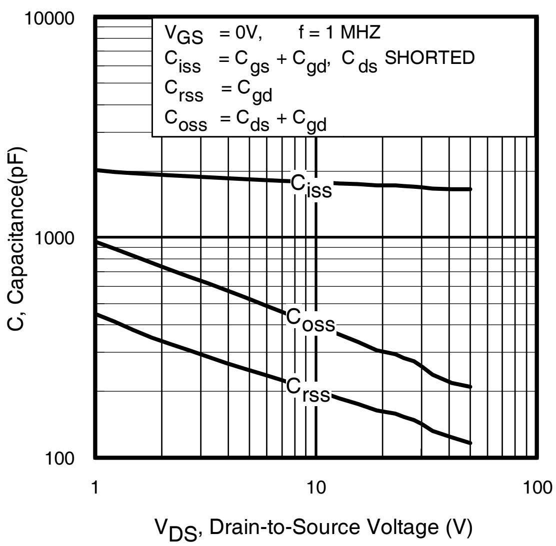



**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage

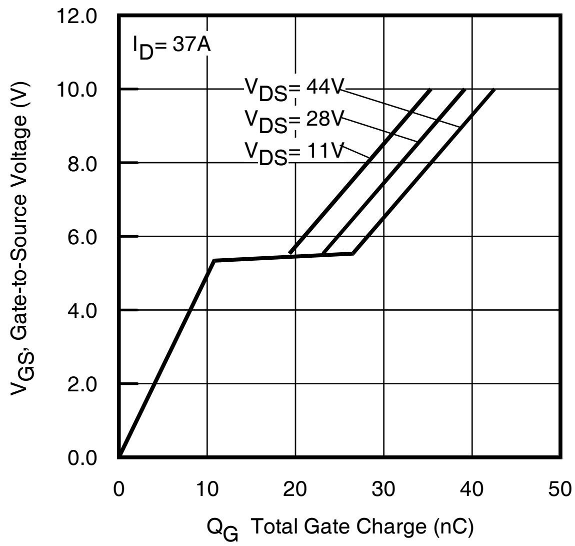



**Fig 6.** Typical Gate Charge vs. Gate-to-Source Voltage

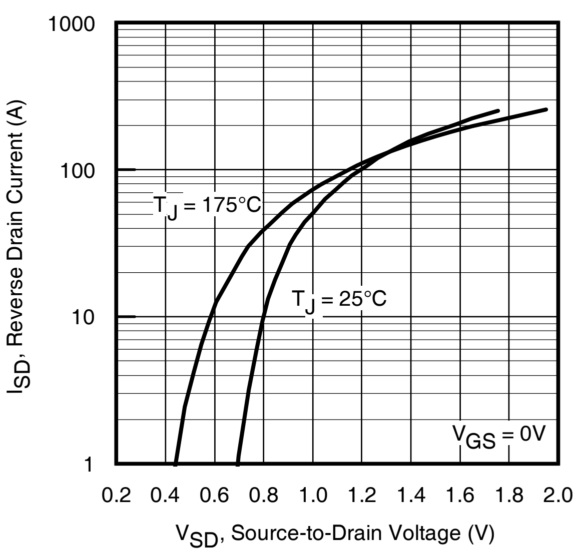



**Fig 7.** Typical Source-Drain Diode Forward Voltage

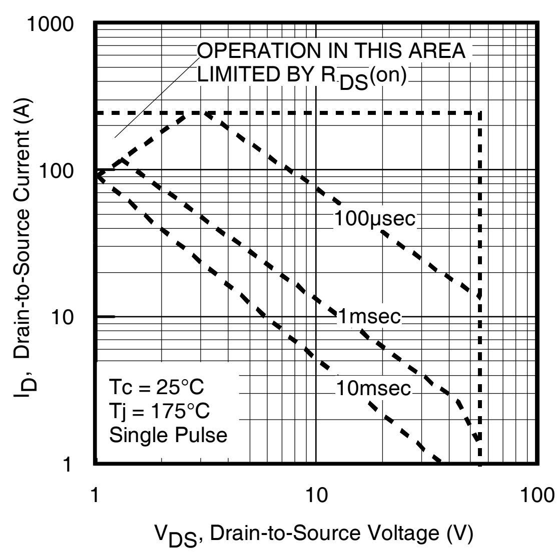



**Fig 8.** Maximum Safe Operating Area

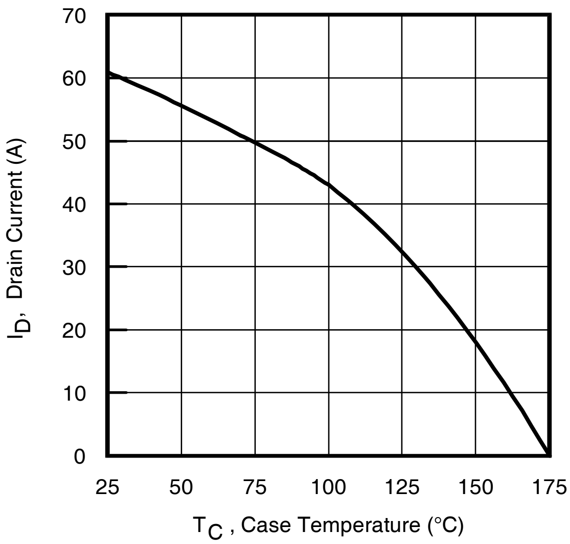



**Fig 9.** Maximum Drain Current vs. Case Temperature

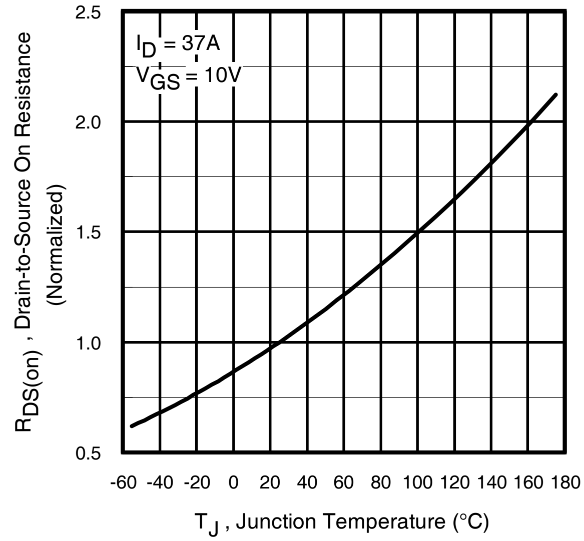



**Fig 10.** Normalized On-Resistance vs. Temperature

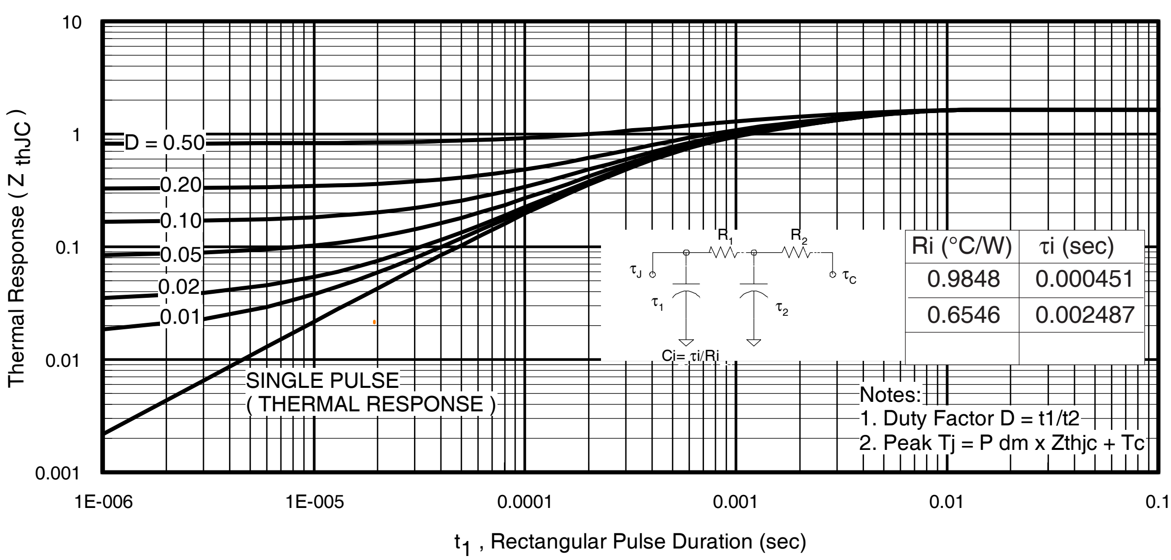



**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

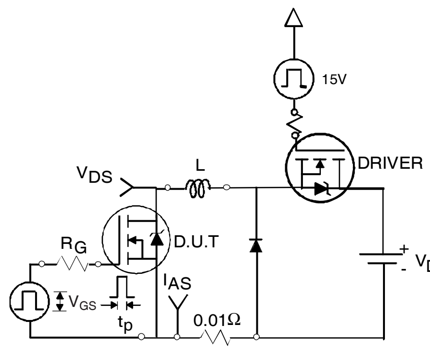



**Fig 12a.** Unclamped Inductive Test Circuit

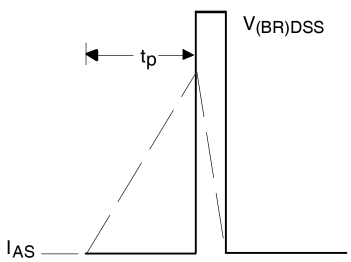



**Fig 12b.** Unclamped Inductive Waveforms

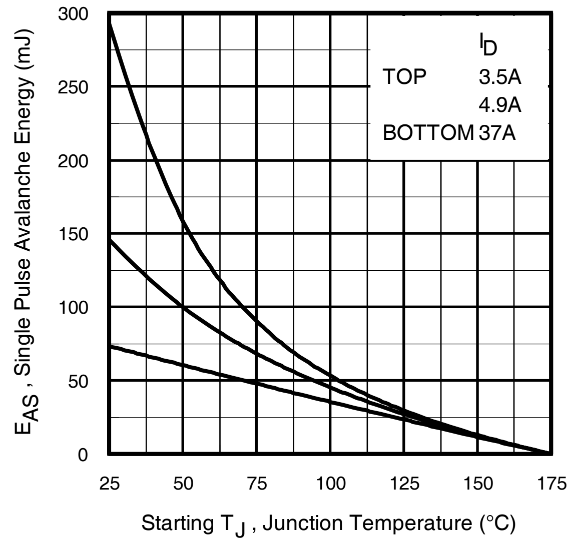



**Fig 12c.** Maximum Avalanche Energy vs. Drain Current

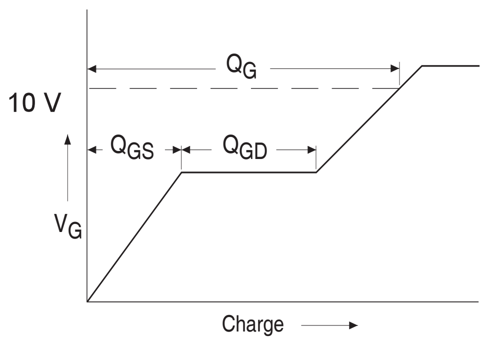



**Fig 13a.** Basic Gate Charge Waveform

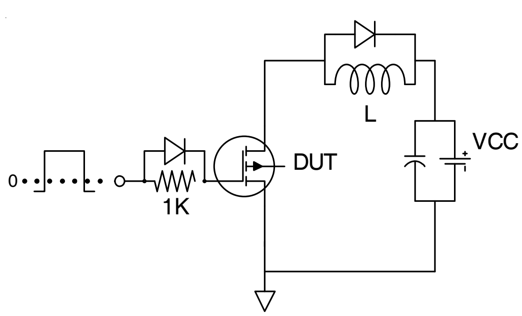



**Fig 13b.** Gate Charge Test Circuit

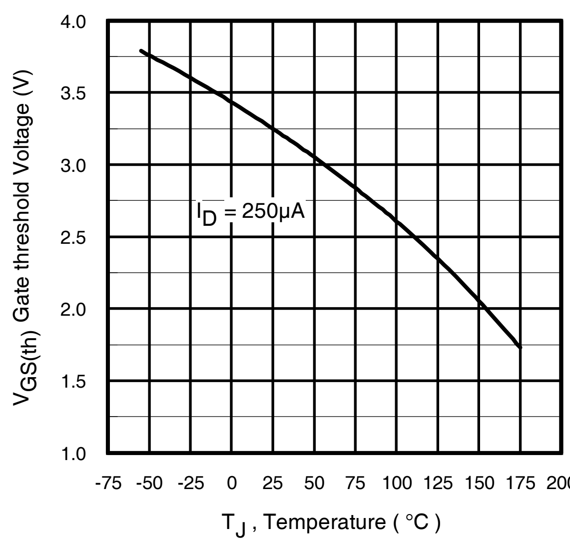



**Fig 14.** Threshold Voltage vs. Temperature

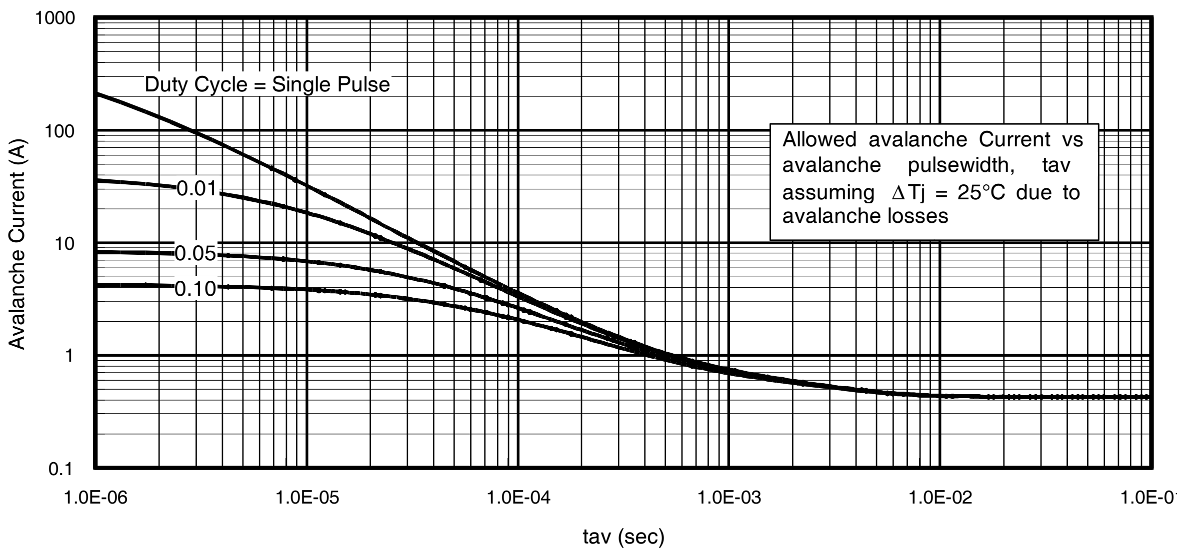



**Fig 15.** Typical Avalanche Current vs.Pulsewidth

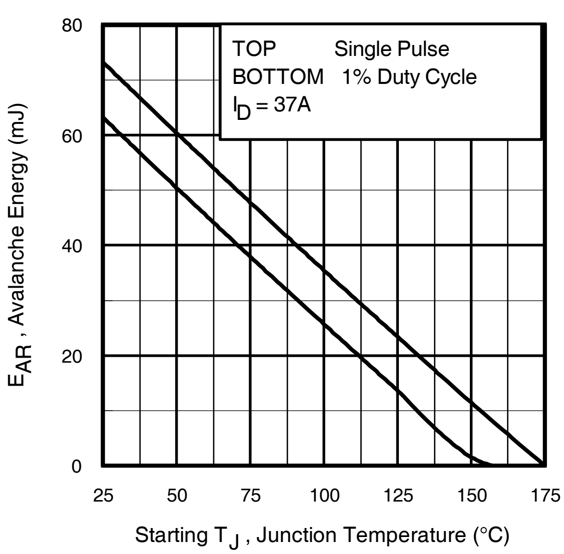



**Fig 16.** Maximum Avalanche Energy vs. Temperature

**Notes on Repetitive Avalanche Curves , Figures 15, 16:**
**(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 12a, 12b.
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. $\Delta T$ = Allowable rise in junction temperature, not to exceed $T_{jmax}$ (assumed as 25°C in Figure 15, 16).
   $t_{av}$ = Average time in avalanche.
   D = Duty cycle in avalanche = $t_{av} \cdot f$
   $Z_{thJC}(D, t_{av})$ = Transient thermal resistance, see figure 11)

$$P_{D\ (ave)} = 1/2\ (\ 1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$
$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$
$$E_{AS\ (AR)} = P_{D\ (ave)} \cdot t_{av}$$

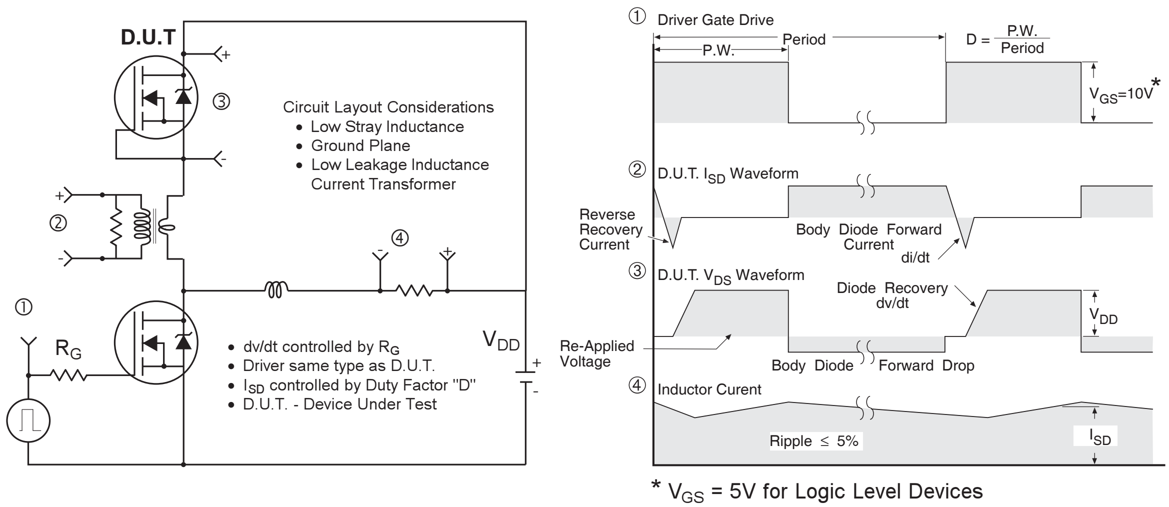



**Fig 17.** Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

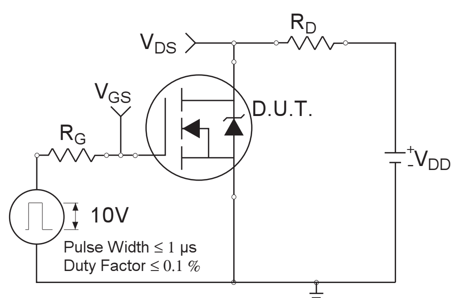



**Fig 18a.** Switching Time Test Circuit

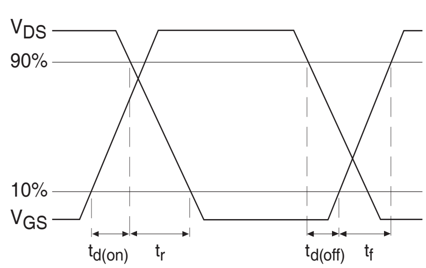
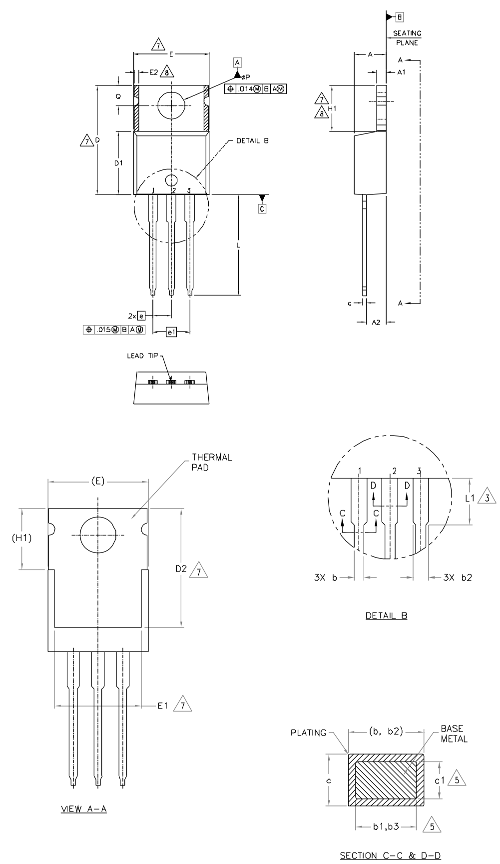



**Fig 18b.** Switching Time Waveforms

## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)




NOTES:

1.– DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M– 1994.
2.– DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
3.– LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4.– DIMENSION D, D1 & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5.– DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.
6.– CONTROLLING DIMENSION : INCHES.
7.– THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
8.– DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
9.– OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 3.56 | 4.83 | .140 | .190 | |
| A1 | 0.51 | 1.40 | .020 | .055 | |
| A2 | 2.03 | 2.92 | .080 | .115 | |
| b | 0.38 | 1.01 | .015 | .040 | |
| b1 | 0.38 | 0.97 | .015 | .038 | 5 |
| b2 | 1.14 | 1.78 | .045 | .070 | |
| b3 | 1.14 | 1.73 | .045 | .068 | 5 |
| c | 0.36 | 0.61 | .014 | .024 | |
| c1 | 0.36 | 0.56 | .014 | .022 | 5 |
| D | 14.22 | 16.51 | .560 | .650 | 4 |
| D1 | 8.38 | 9.02 | .330 | .355 | |
| D2 | 11.68 | 12.88 | .460 | .507 | 7 |
| E | 9.65 | 10.67 | .380 | .420 | 4,7 |
| E1 | 6.86 | 8.89 | .270 | .350 | 7 |
| E2 | – | 0.76 | – | .030 | 8 |
| e | 2.54 BSC | | .100 BSC | | |
| e1 | 5.08 BSC | | .200 BSC | | |
| H1 | 5.84 | 6.86 | .230 | .270 | 7,8 |
| L | 12.70 | 14.73 | .500 | .580 | |
| L1 | 3.56 | 4.06 | .140 | .160 | 3 |
| øP | 3.54 | 4.08 | .139 | .161 | |
| Q | 2.54 | 3.42 | .100 | .135 | |

LEAD ASSIGNMENTS

HEXFET

1.– GATE
2.– DRAIN
3.– SOURCE

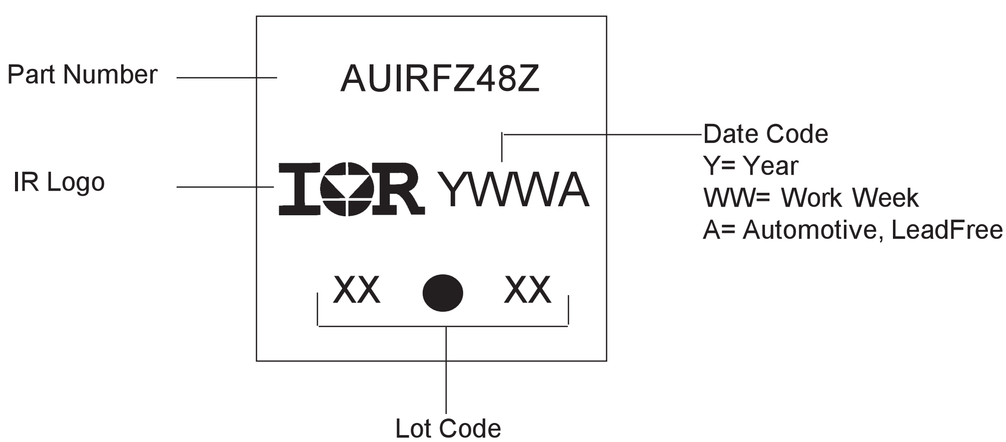
IGBTs, CoPACK

1.– GATE
2.– COLLECTOR
3.– EMITTER

DIODES

1.– ANODE
2.– CATHODE
3.– ANODE

## TO-220AB Part Marking Information

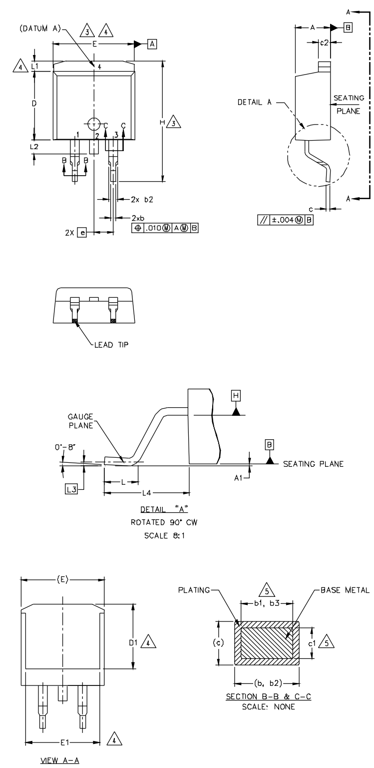



TO-220AB packages are not recommended for Surface Mount Application.

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

## D²Pak (TO-263AB) Package Outline

Dimensions are shown in millimeters (inches)



| 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 | – | 1.78 | – | .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, 4.– CATHODE
3.– ANODE

HEXFET

1.– GATE
2, 4.– DRAIN
3.– SOURCE

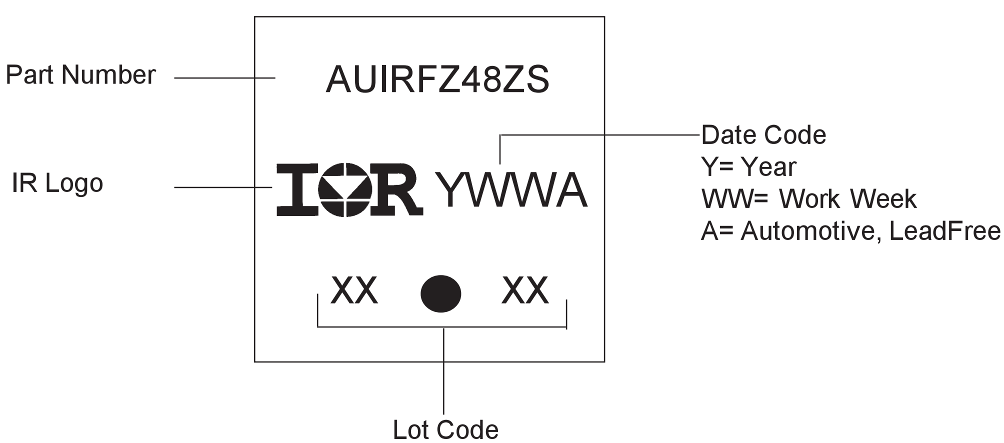
IGBTs, CoPACK

1.– GATE
2, 4.– 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 [.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.

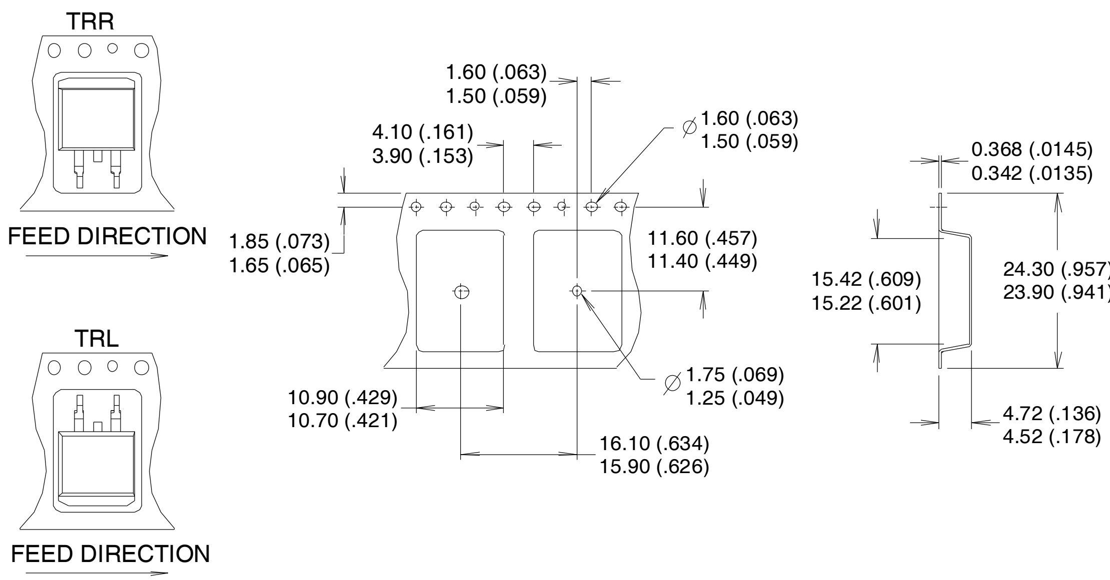
## D²Pak (TO-263AB) Part Marking Information

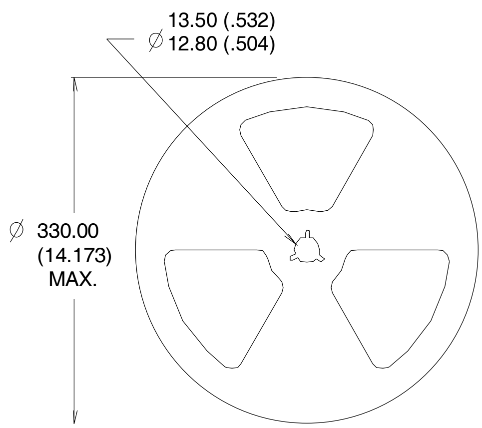


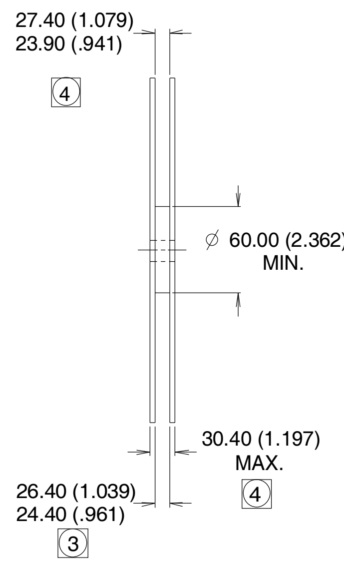

**Note: For the most current drawing please refer to IR website at http://www.irf.com/package/**

## D²Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)




NOTES :

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

## Ordering Information

| Base part | Package Type | Standard Pack | | Complete Part Number |
|---|---|---|---|---|
| | | Form | Quantity | |
| AUIRFZ48Z | TO-220 | Tube | 50 | AUIRFZ48Z |
| AUIRFZ48ZS | D2Pak | Tube | 50 | AUIRFZ48ZS |
| | | Tape and Reel Left | 800 | AUIRFZ48ZSTRL |
| | | Tape and Reel Right | 800 | AUIRFZ48ZSTRR |

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