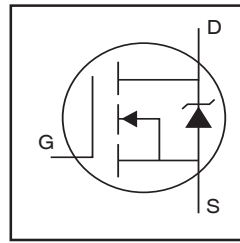


# AUIRF3004WL

## WIDELEAD HEXFET® Power MOSFET

### Features

- Advanced Process Technology
- Ultra Low On-Resistance
- 50% Lower Lead Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to  $T_{jmax}$
- Lead-Free, RoHS Compliant
- Automotive Qualified \*



|                         |        |
|-------------------------|--------|
| $V_{(BR)DSS}$           | 40V    |
| $R_{DS(on)}$ typ.       | 1.27mΩ |
| max.                    | 1.40mΩ |
| $I_D$ (Silicon Limited) | 386A ① |
| $I_D$ (Package Limited) | 240A   |

### Description

Specifically design for automotive applications this Widelead TO-262 package part has the advantage of having over 50% lower lead resistance and delivering over 20% lower  $R_{DS(on)}$  when compared with a traditional TO-262 package housing the same silicon die. This greatly helps in reducing condition losses, achieving higher current levels or enabling a system to run cooler and have improved efficiency. 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 and other applications.



|      |       |        |
|------|-------|--------|
| 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 |
|-----------------------------------|------------------------------------------------------------|----------------------------|-------|
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V (Silicon Limited) | 386①                       | A     |
| $I_D$ @ $T_C = 100^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V (Silicon Limited) | 273①                       |       |
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V (Package Limited) | 240                        |       |
| $I_{DM}$                          | Pulsed Drain Current ②                                     | 1544                       |       |
| $P_D$ @ $T_C = 25^\circ\text{C}$  | Maximum Power Dissipation                                  | 375                        | W     |
|                                   | Linear Derating Factor                                     | 2.5                        | W/°C  |
| $V_{GS}$                          | Gate-to-Source Voltage                                     | ± 20                       | V     |
| $E_{AS}$ (Thermally limited)      | Single Pulse Avalanche Energy ③                            | 470                        | mJ    |
| $I_{AR}$                          | Avalanche Current ②                                        | See Fig. 14, 15, 22a, 22b, | A     |
| $E_{AR}$                          | Repetitive Avalanche Energy ②                              |                            | mJ    |
| $dv/dt$                           | Peak Diode Recovery ④                                      | 6.1                        | V/ns  |
| $T_J$                             | Operating Junction and                                     | -55 to + 175               | °C    |
| $T_{STG}$                         | Storage Temperature Range                                  |                            |       |
|                                   | Soldering Temperature, for 10 seconds                      |                            |       |

### Thermal Resistance

|                 | Parameter          | Typ. | Max. | Units |
|-----------------|--------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case ⑤ | —    | 0.40 | °C/W  |

HEXFET® is a registered trademark of International Rectifier.

\*Qualification standards can be found at <http://www.irf.com/>

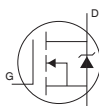
**Static Electrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

|                                 | Parameter                            | Min. | Typ.  | Max. | Units               | Conditions                                           |
|---------------------------------|--------------------------------------|------|-------|------|---------------------|------------------------------------------------------|
| $V_{(BR)DSS}$                   | Drain-to-Source Breakdown Voltage    | 40   | —     | —    | V                   | $V_{GS} = 0V, I_D = 250\mu A$                        |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.038 | —    | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D = 5mA$ ⑤      |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | 1.27  | 1.40 | m $\Omega$          | $V_{GS} = 10V, I_D = 195A$ ⑤                         |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 2.0  | —     | 4.0  | V                   | $V_{DS} = V_{GS}, I_D = 250\mu A$                    |
| gfs                             | Forward Transconductance             | 330  | —     | —    | S                   | $V_{DS} = 10V, I_D = 195A$                           |
| $R_G$                           | Internal Gate Resistance             | —    | 2.7   | —    | $\Omega$            |                                                      |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —     | 20   | $\mu A$             | $V_{DS} = 40V, V_{GS} = 0V$                          |
|                                 |                                      | —    | —     | 250  |                     | $V_{DS} = 32V, V_{GS} = 0V, T_J = 125^\circ\text{C}$ |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —     | 100  | nA                  | $V_{GS} = 20V$                                       |
|                                 | Gate-to-Source Reverse Leakage       | —    | —     | -100 |                     | $V_{GS} = -20V$                                      |

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

|                             | Parameter                                     | Min. | Typ. | Max. | Units | Conditions                                        |
|-----------------------------|-----------------------------------------------|------|------|------|-------|---------------------------------------------------|
| $Q_g$                       | Total Gate Charge                             | —    | 140  | 210  | nC    | $I_D = 232A$                                      |
| $Q_{gs}$                    | Gate-to-Source Charge                         | —    | 53   | —    |       | $V_{DS} = 20V$                                    |
| $Q_{gd}$                    | Gate-to-Drain ("Miller") Charge               | —    | 49   | —    |       | $V_{GS} = 10V$ ⑤                                  |
| $Q_{sync}$                  | Total Gate Charge Sync. ( $Q_g - Q_{gd}$ )    | —    | 91   | —    |       | $I_D = 232A, V_{DS} = 0V, V_{GS} = 10V$ ⑤         |
| $t_{d(on)}$                 | Turn-On Delay Time                            | —    | 19   | —    | ns    | $V_{DD} = 26V$                                    |
| $t_r$                       | Rise Time                                     | —    | 220  | —    |       | $I_D = 232A$                                      |
| $t_{d(off)}$                | Turn-Off Delay Time                           | —    | 90   | —    |       | $R_G = 2.7\Omega$                                 |
| $t_f$                       | Fall Time                                     | —    | 130  | —    |       | $V_{GS} = 10V$ ⑤                                  |
| $C_{iss}$                   | Input Capacitance                             | —    | 9450 | —    | pF    | $V_{GS} = 0V$                                     |
| $C_{oss}$                   | Output Capacitance                            | —    | 1930 | —    |       | $V_{DS} = 32V$                                    |
| $C_{rss}$                   | Reverse Transfer Capacitance                  | —    | 975  | —    |       | $f = 1.0MHz$ , See Fig.5                          |
| $C_{oss \text{ eff. (ER)}}$ | Effective Output Capacitance (Energy Related) | —    | 2330 | —    |       | $V_{GS} = 0V, V_{DS} = 0V$ to $32V$ ⑦, See Fig.11 |
| $C_{oss \text{ eff. (TR)}}$ | Effective Output Capacitance (Time Related)   | —    | 2815 | —    |       | $V_{GS} = 0V, V_{DS} = 0V$ to $32V$ ⑧             |

**Diode Characteristics**

|           | Parameter                              | Min.                                                                 | Typ. | Max. | Units | Conditions                                                                                                                                           |
|-----------|----------------------------------------|----------------------------------------------------------------------|------|------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_S$     | Continuous Source Current (Body Diode) | —                                                                    | —    | 386① | A     | MOSFET symbol showing the integral reverse p-n junction diode.  |
| $I_{SM}$  | Pulsed Source Current (Body Diode) ②   | —                                                                    | —    | 1544 |       |                                                                                                                                                      |
| $V_{SD}$  | Diode Forward Voltage                  | —                                                                    | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 195A, V_{GS} = 0V$ ⑤                                                                                                  |
| $t_{rr}$  | Reverse Recovery Time                  | —                                                                    | 41   | 62   | ns    | $T_J = 25^\circ\text{C}$ $V_R = 34V$ ,                                                                                                               |
|           |                                        | —                                                                    | 51   | 77   |       | $T_J = 125^\circ\text{C}$ $I_F = 232A$                                                                                                               |
| $Q_{rr}$  | Reverse Recovery Charge                | —                                                                    | 62   | 93   | nC    | $T_J = 25^\circ\text{C}$ $di/dt = 100A/\mu s$ ⑤                                                                                                      |
|           |                                        | —                                                                    | 99   | 149  |       | $T_J = 125^\circ\text{C}$                                                                                                                            |
| $I_{RRM}$ | Reverse Recovery Current               | —                                                                    | 2.3  | —    | A     | $T_J = 25^\circ\text{C}$                                                                                                                             |
| $t_{on}$  | 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 240A. Note that current limitations arising from heating of the device leads may occur with some lead mounting arrangements. (Refer to AN-1140 <http://www.irf.com/technical-info/appnotes/an-1140.pdf>)
- ② Repetitive rating; pulse width limited by max. junction temperature.
- ③ Limited by  $T_{Jmax}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.018mH$   
 $R_G = 50\Omega$ ,  $I_{AS} = 232A$ ,  $V_{GS} = 10V$ . Part not recommended for use above this value.
- ④  $I_{SD} \leq 232A$ ,  $di/dt \leq 907A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 175^\circ\text{C}$ .
- ⑤ Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .
- ⑥  $C_{oss \text{ eff. (TR)}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to  $80\% V_{DSS}$ .
- ⑦  $C_{oss \text{ eff. (ER)}}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to  $80\% V_{DSS}$ .
- ⑧  $R_\theta$  is measured at  $T_J$  approximately  $90^\circ\text{C}$ .

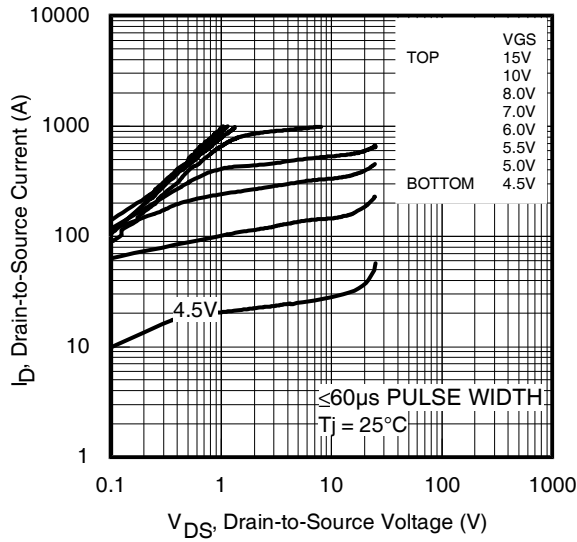


Fig 1. Typical Output Characteristics

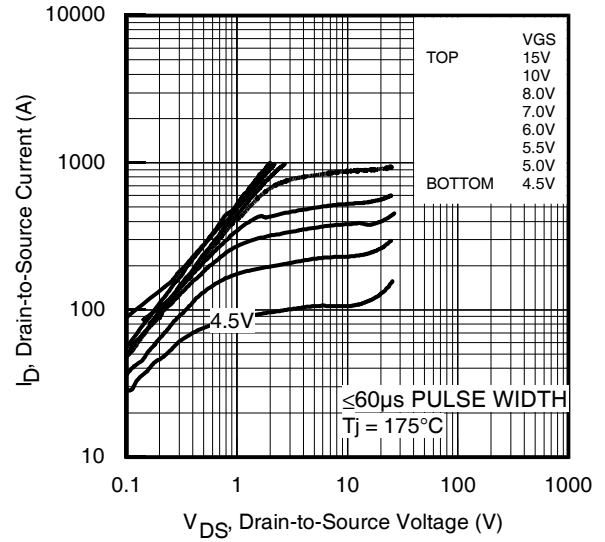


Fig 2. Typical Output Characteristics

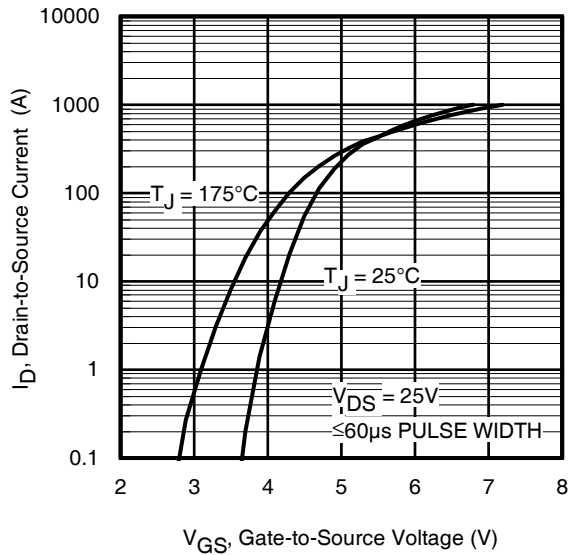


Fig 3. Typical Transfer Characteristics

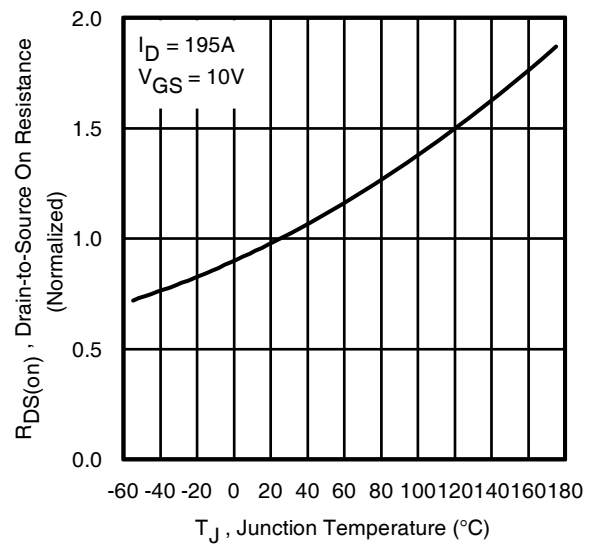


Fig 4. Normalized On-Resistance vs. Temperature

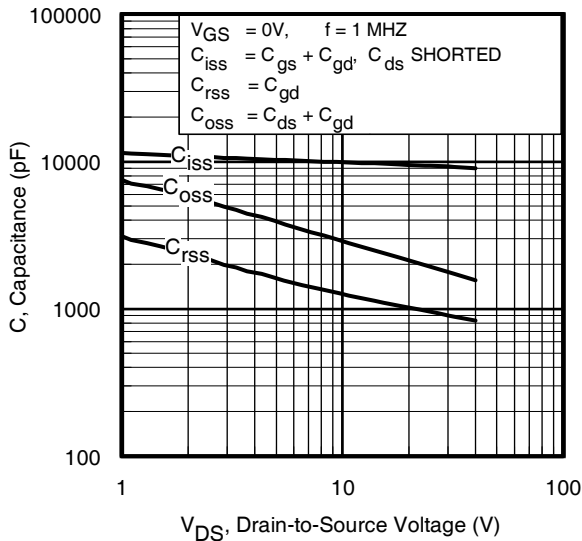


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

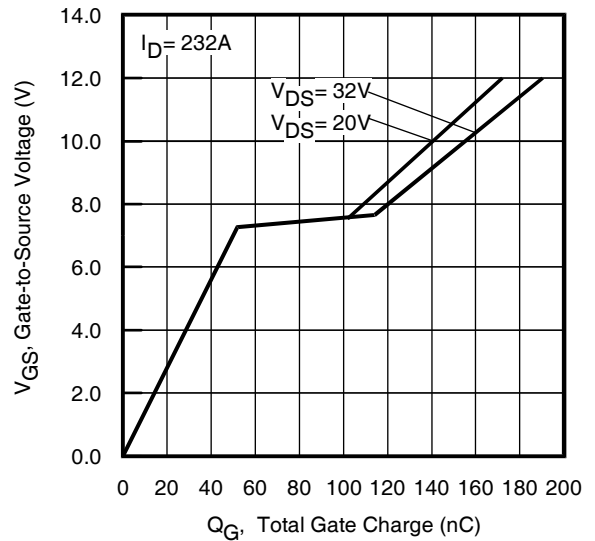
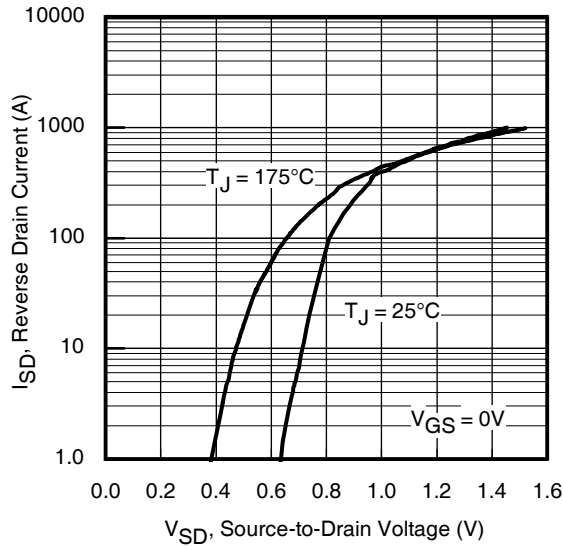
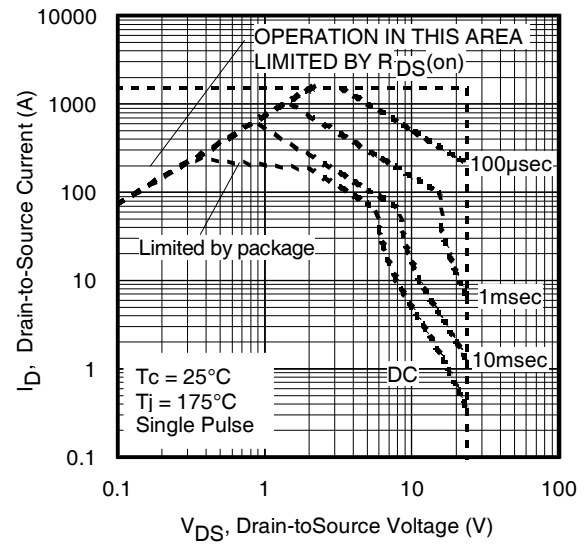


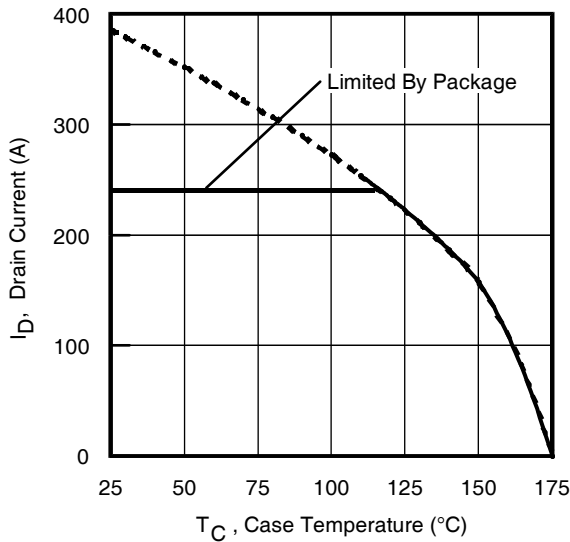
Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage



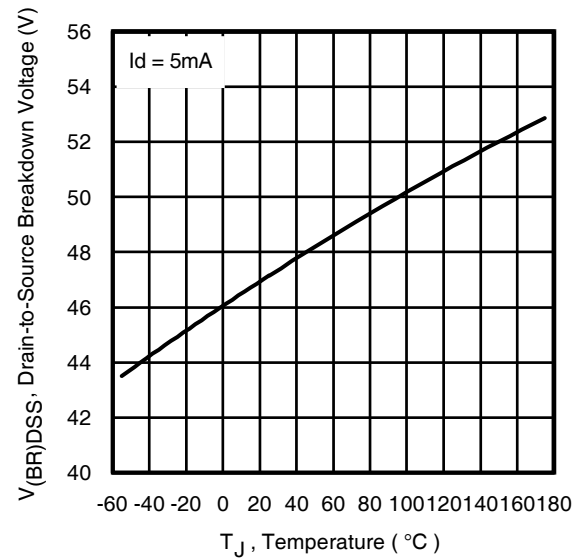
**Fig 7.** Typical Source-Drain Diode Forward Voltage



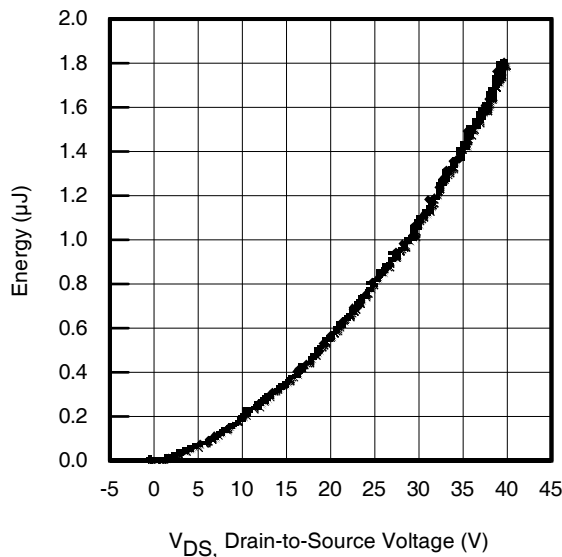
**Fig 8.** Maximum Safe Operating Area



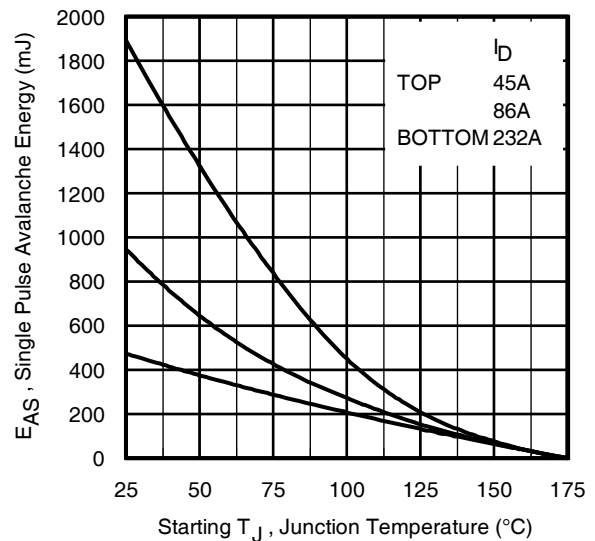
**Fig 9.** Maximum Drain Current vs. Case Temperature



**Fig 10.** Drain-to-Source Breakdown Voltage



**Fig 11.** Typical  $C_{OSS}$  Stored Energy



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

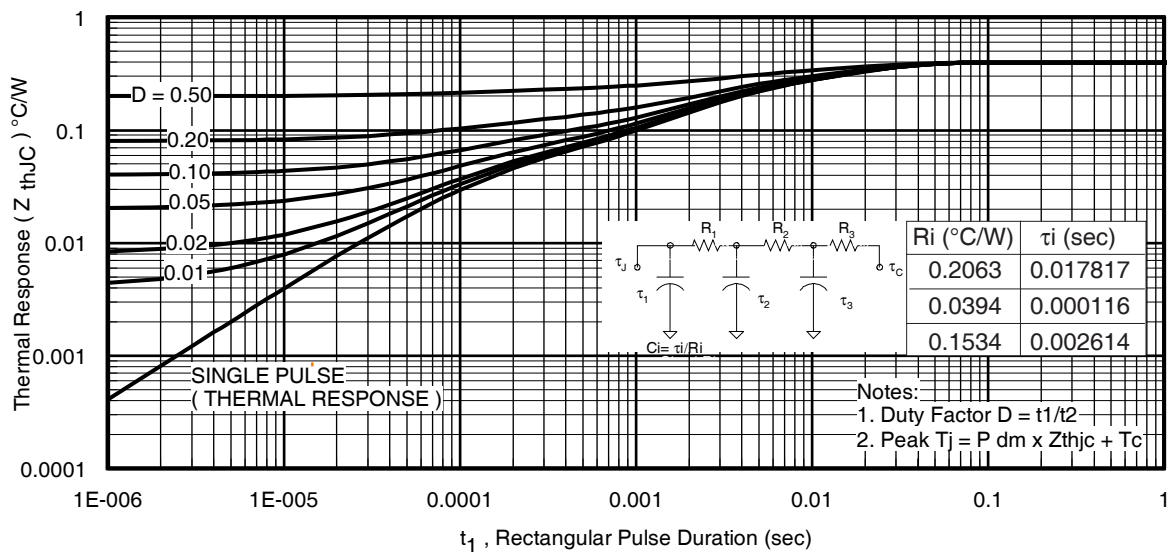


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

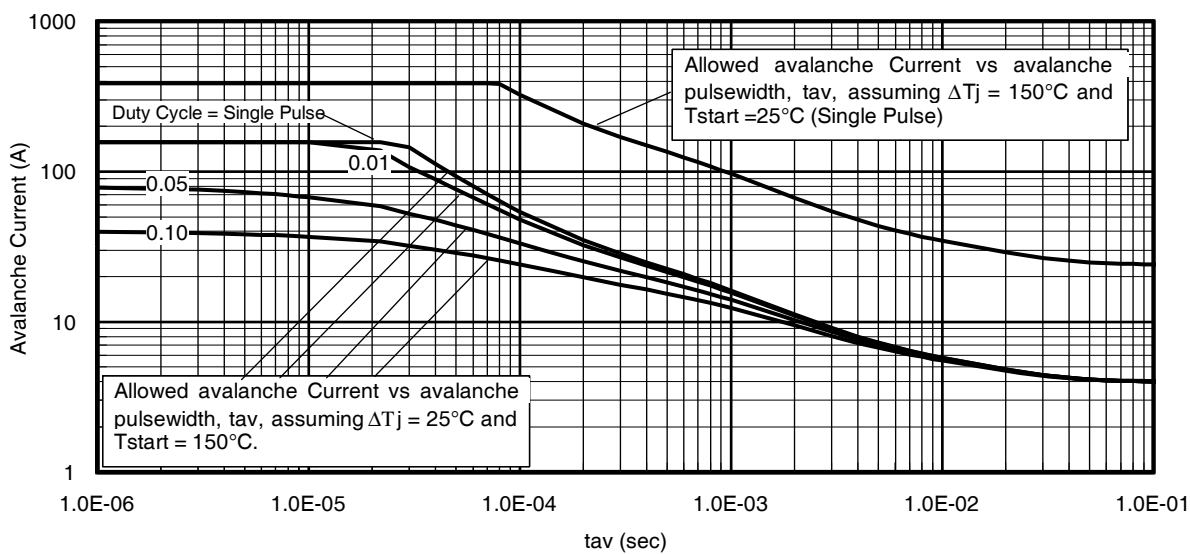
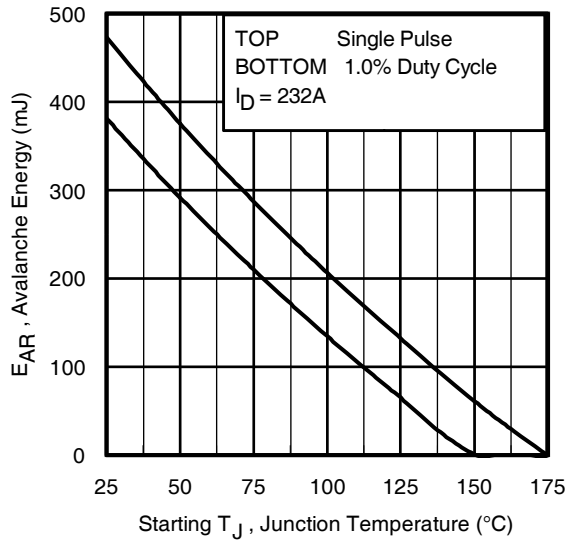


Fig 14. Typical Avalanche Current vs. Pulsewidth



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

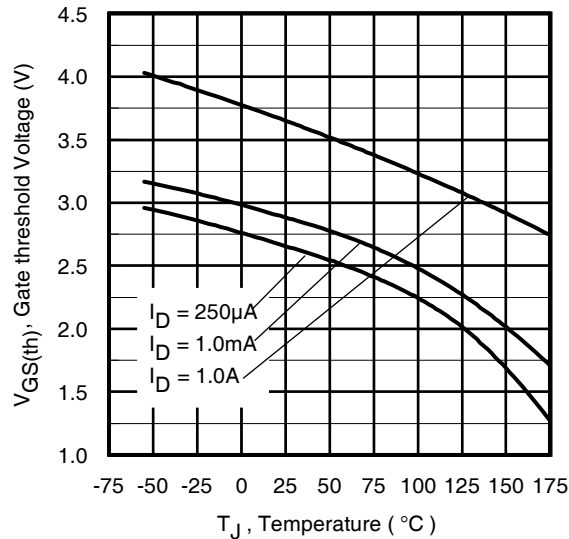
1. Avalanche failures assumption:  
Purely a thermal phenomenon and failure occurs at a temperature far in excess of  $T_{jmax}$ . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as  $T_{jmax}$  is not exceeded.
3. Equation below based on circuit and waveforms shown in Figure 22a, 22b.
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 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)

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

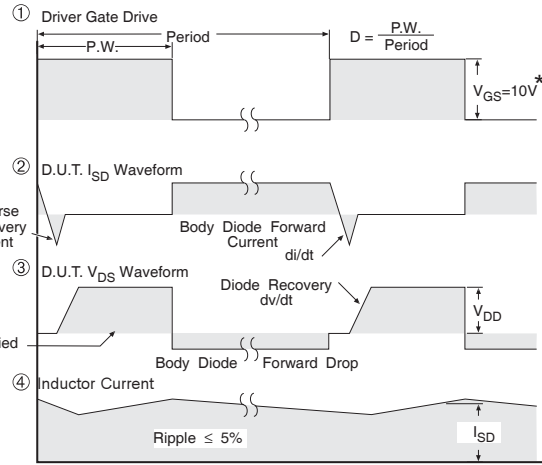
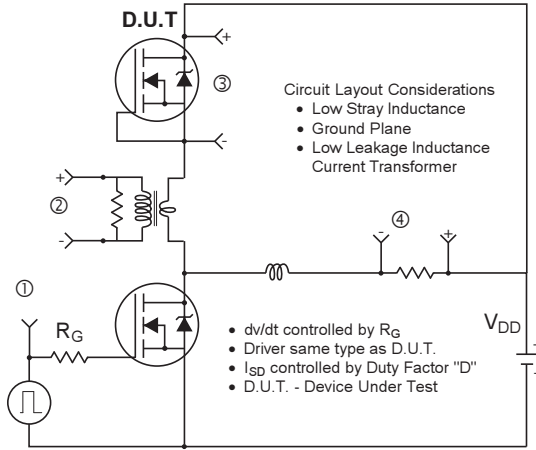
$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

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

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

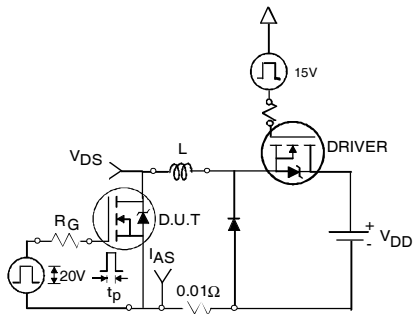


**Fig 16.** Threshold Voltage vs. Temperature

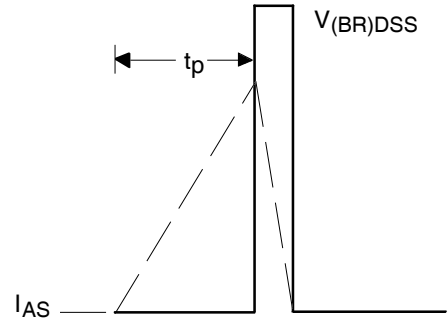


\*  $V_{GS} = 5V$  for Logic Level Devices

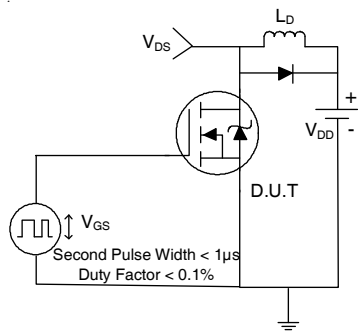
**Fig 21. Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs**



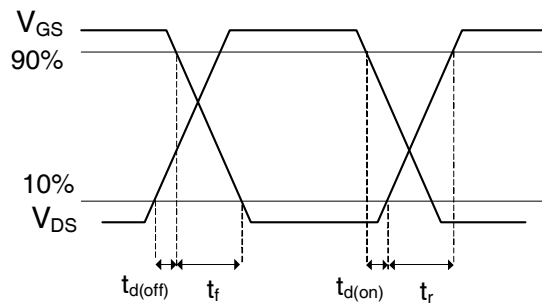
**Fig 22a. Unclamped Inductive Test Circuit**



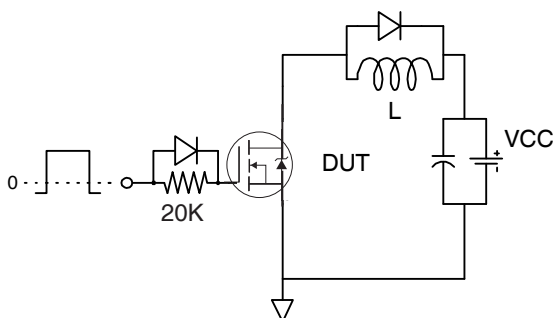
**Fig 22b. Unclamped Inductive Waveforms**



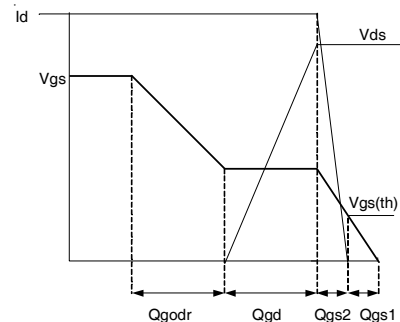
**Fig 23a. Switching Time Test Circuit**



**Fig 23b. Switching Time Waveforms**



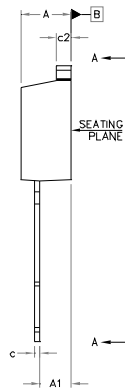
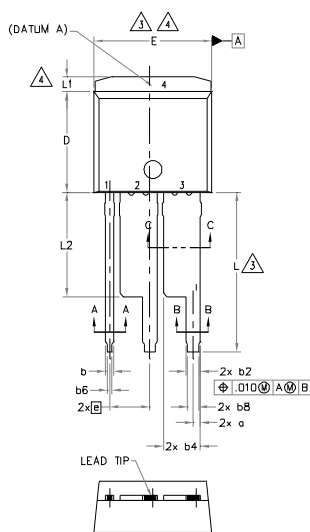
**Fig 24a. Gate Charge Test Circuit**



**Fig 24b. Gate Charge Waveform**

## TO-262 WideLead 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     |
| A1     | 2.03        | 3.02  | .080     | .119 |       |
| a      | 0.20        | 0.51  | .008     | .020 |       |
| b      | 0.51        | 0.91  | .020     | .036 |       |
| b1     | 0.51        | 0.81  | .020     | .032 |       |
| b2     | 1.07        | 1.47  | 0.42     | .058 | 5     |
| b3     | 1.07        | 1.37  | .042     | .054 |       |
| b4     | 3.05        | 3.45  | .120     | .136 | 5     |
| b5     | 3.05        | 3.35  | .120     | .132 |       |
| b6     | 0.25        | 0.61  | .010     | .024 | 5     |
| b7     | 0.25        | 0.51  | .010     | .020 |       |
| b8     | 0.76        | 1.17  | .030     | .046 | 5     |
| b9     | 0.76        | 1.07  | .030     | .022 |       |
| c      | 0.38        | 0.74  | .015     | .029 | 5     |
| c1     | 0.38        | 0.58  | .015     | .023 |       |
| c2     | 1.14        | 1.65  | .045     | .065 | 3     |
| D      | 8.51        | 9.65  | .335     | .380 |       |
| D1     | 6.86        | 7.42  | .270     | .292 | 4     |
| E      | 9.65        | 10.67 | .380     | .420 | 3,4   |
| E1     | 6.22        | 8.48  | .245     | .334 | 4     |
| e      | 3.81 BSC    |       | .150 BSC |      | 4     |
| L      | 13.46       | 14.10 | .530     | .555 |       |
| L1     | -           | 1.65  | -        | .065 |       |
| L2     | 8.64        | 9.40  | .340     | .370 |       |

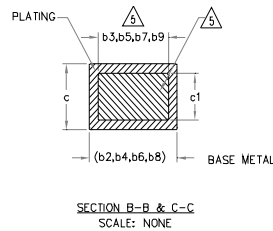
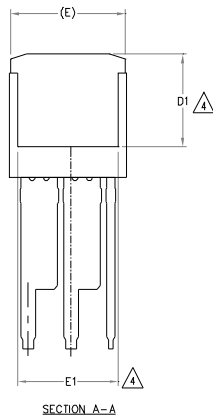
### NOTES:

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 b3, b5, b7, b9 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.

### LEAD ASSIGNMENTS

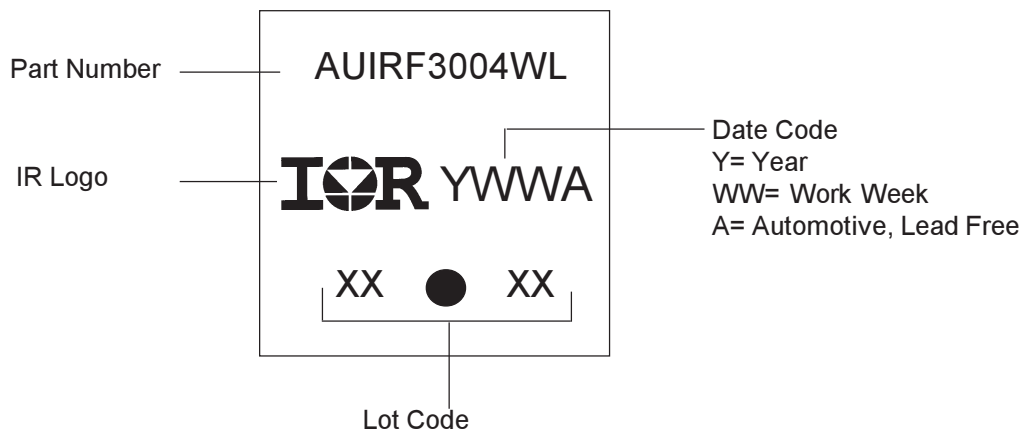
#### HEXFET

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



SECTION B-B & C-C  
SCALE: NONE

## TO-262 WideLead Part Marking Information



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

### Ordering Information

| Base part number | Package Type    | Standard Pack |          | Complete Part Number |
|------------------|-----------------|---------------|----------|----------------------|
|                  |                 | Form          | Quantity |                      |
| AUIRF3004WL      | TO-262 WideLead | Tube          | 50       | AUIRF3004WL          |

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For technical support, please contact IR’s Technical Assistance Center

<http://www.irf.com/technical-info/>

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