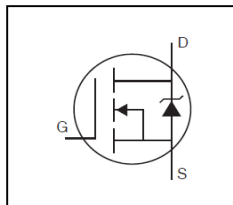


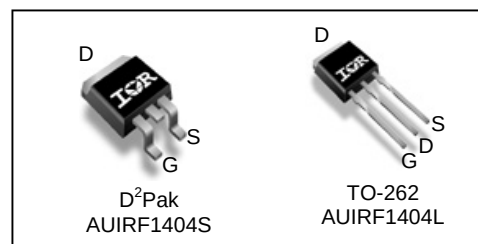
## Features

- Advanced Planar Technology
- Dynamic  $dv/dt$  Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Repetitive Avalanche Allowed up to  $T_{jmax}$
- Lead-Free, RoHS Compliant
- Automotive Qualified \*

HEXFET® Power MOSFET



|                          |              |
|--------------------------|--------------|
| $V_{DS}$                 | <b>40V</b>   |
| $R_{DS(on)}$ <b>typ.</b> | <b>3.5mΩ</b> |
| <b>max.</b>              | <b>4.0mΩ</b> |
| $I_D$ (Silicon Limited)  | <b>162A®</b> |
| $I_D$ (Package Limited)  | <b>75A</b>   |



|          |          |          |
|----------|----------|----------|
| <b>G</b> | <b>D</b> | <b>S</b> |
| Gate     | Drain    | Source   |

## Description

Specifically designed for Automotive applications, this Stripe Planar design of HEXFET® Power MOSFETs utilizes the latest processing techniques to achieve low on-resistance per silicon area. This benefit combined with the fast switching speed and ruggedized device design that HEXFET power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in Automotive and a wide variety of other applications.

| Base part number | Package Type | Standard Pack      |          | Orderable Part Number |
|------------------|--------------|--------------------|----------|-----------------------|
|                  |              | Form               | Quantity |                       |
| AUIRF1404L       | TO-262       | Tube               | 50       | AUIRF1404L            |
| AUIRF1404S       | D²-Pak       | Tube               | 50       | AUIRF1404S            |
|                  |              | Tape and Reel Left | 800      | AUIRF1404STRL         |

## 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.

| Symbol                            | Parameter                                                    | Max.         | Units |
|-----------------------------------|--------------------------------------------------------------|--------------|-------|
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V (Silicon Limited) ⑦ | 162®         | A     |
| $I_D$ @ $T_C = 100^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V (Silicon Limited) ⑦ | 115®         |       |
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V (Package Limited)   | 75           |       |
| $I_{DM}$                          | Pulsed Drain Current ①⑦                                      | 650          |       |
| $P_D$ @ $T_A = 25^\circ\text{C}$  | Maximum Power Dissipation                                    | 3.8          | W     |
| $P_D$ @ $T_C = 25^\circ\text{C}$  | Maximum Power Dissipation                                    | 200          |       |
|                                   | Linear Derating Factor                                       | 1.3          | W/°C  |
| $V_{GS}$                          | Gate-to-Source Voltage                                       | ± 20         | V     |
| $E_{AS}$                          | Single Pulse Avalanche Energy (Thermally Limited) ②⑦         | 519          | mJ    |
| $I_{AR}$                          | Avalanche Current ①                                          | 95           | A     |
| $E_{AR}$                          | Repetitive Avalanche Energy ①                                | 20           | mJ    |
| $Dv/dt$                           | Peak Diode Recovery ③⑦                                       | 5.0          | V/ns  |
| $T_J$                             | Operating Junction and                                       | -55 to + 175 | °C    |
| $T_{STG}$                         | Storage Temperature Range                                    |              |       |
|                                   | Soldering Temperature, for 10 seconds (1.6mm from case)      | 300          |       |

## Thermal Resistance

| Symbol          | Parameter                                        | Typ. | Max. | Units |
|-----------------|--------------------------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case ⑨                               | —    | 0.75 | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient ( PCB Mount, steady state) ⑧ |      | 40   |       |

HEXFET® is a registered trademark of Infineon.

\*Qualification standards can be found at [www.infineon.com](http://www.infineon.com)

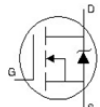
**Static @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

|                                 | 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  | —    | 0.036 | —    | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D = 1mA$        |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | 3.5   | 4.0  | m $\Omega$          | $V_{GS} = 10V, I_D = 95A$ ④                          |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 2.0  | —     | 4.0  | V                   | $V_{DS} = V_{GS}, I_D = 250\mu A$                    |
| $g_{fs}$                        | Forward Trans conductance            | 106  | —     | —    | S                   | $V_{DS} = 25V, I_D = 60A$ ⑦                          |
| $I_{DSS}$                       | 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       | —    | —     | 200  | nA                  | $V_{GS} = 20V$                                       |
|                                 | Gate-to-Source Reverse Leakage       | —    | —     | -200 |                     | $V_{GS} = -20V$                                      |

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

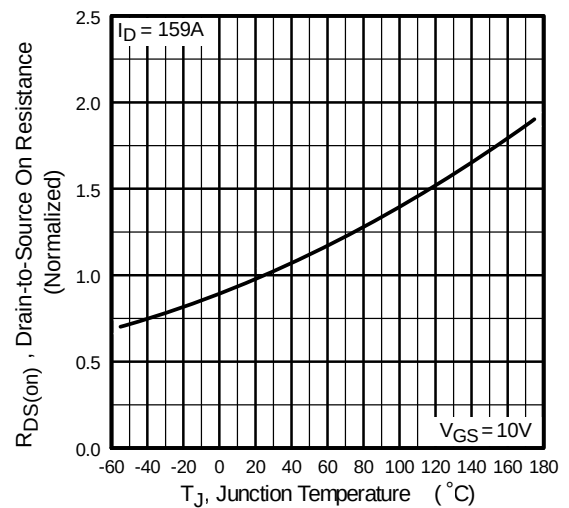
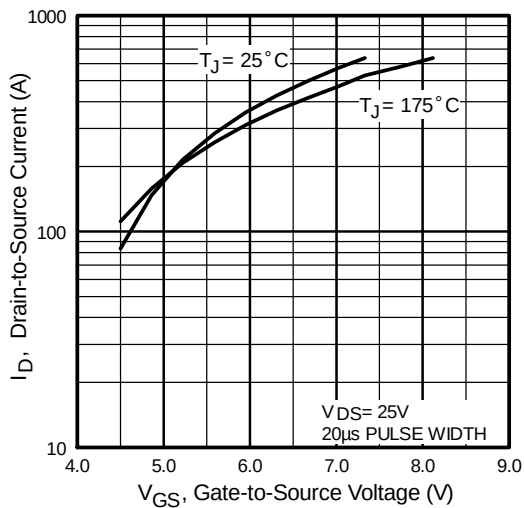
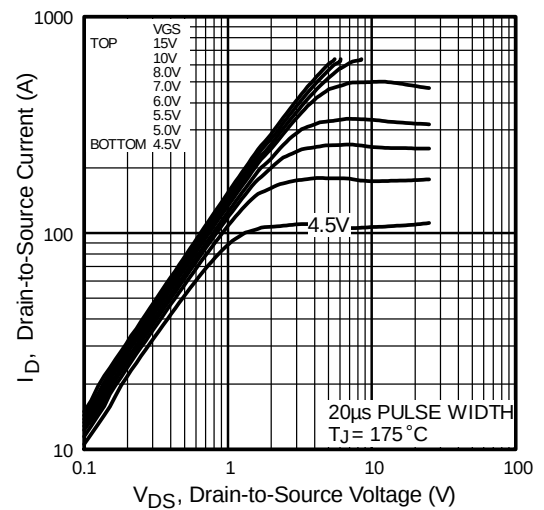
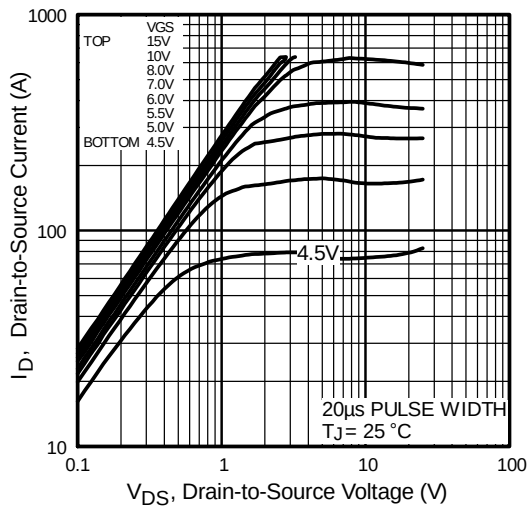
|                       |                              |   |      |     |    |                                            |
|-----------------------|------------------------------|---|------|-----|----|--------------------------------------------|
| $Q_g$                 | Total Gate Charge            | — | 160  | 200 | nC | $I_D = 95A$                                |
| $Q_{gs}$              | Gate-to-Source Charge        | — | 35   | —   |    | $V_{DS} = 32V$                             |
| $Q_{gd}$              | Gate-to-Drain Charge         | — | 42   | 60  |    | $V_{GS} = 10V$ ④ ⑦                         |
| $t_{d(on)}$           | Turn-On Delay Time           | — | 17   | —   | ns | $V_{DD} = 20V$                             |
| $t_r$                 | Rise Time                    | — | 140  | —   |    | $I_D = 95A$                                |
| $t_{d(off)}$          | Turn-Off Delay Time          | — | 72   | —   |    | $R_G = 2.5\Omega$                          |
| $t_f$                 | Fall Time                    | — | 26   | —   |    | $R_D = 0.21\Omega$ ④ ⑦                     |
| $L_S$                 | Internal Source Inductance   | — | 7.5  | —   | nH | Between lead, and center of die contact    |
| $C_{iss}$             | Input Capacitance            | — | 7360 | —   | pF | $V_{GS} = 0V$                              |
| $C_{oss}$             | Output Capacitance           | — | 1680 | —   |    | $V_{DS} = 25V$                             |
| $C_{rss}$             | Reverse Transfer Capacitance | — | 240  | —   |    | $f = 1.0MHz$ , See Fig. 5 ⑦                |
| $C_{oss}$             | Output Capacitance           | — | 6630 | —   |    | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0MHz$   |
| $C_{oss}$             | Output Capacitance           | — | 1490 | —   |    | $V_{GS} = 0V, V_{DS} = 32V, f = 1.0MHz$    |
| $C_{oss\text{ eff.}}$ | Effective Output Capacitance | — | 1540 | —   |    | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 32V$ |

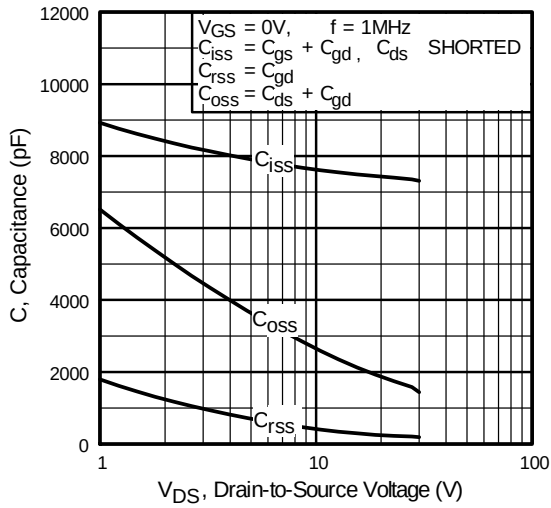
**Diode Characteristics**

|          | Parameter                              | Min.                                                                        | Typ. | Max. | Units | Conditions                                                                                                                                           |
|----------|----------------------------------------|-----------------------------------------------------------------------------|------|------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current (Body Diode) | —                                                                           | —    | 162⑥ | A     | MOSFET symbol showing the integral reverse p-n junction diode.  |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ①   | —                                                                           | —    | 650  |       |                                                                                                                                                      |
| $V_{SD}$ | Diode Forward Voltage                  | —                                                                           | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 95A, V_{GS} = 0V$ ④                                                                                                   |
| $t_{rr}$ | Reverse Recovery Time                  | —                                                                           | 71   | 110  | ns    | $T_J = 25^\circ\text{C}, I_F = 95A$                                                                                                                  |
| $Q_{rr}$ | Reverse Recovery Charge                | —                                                                           | 180  | 270  | nC    | $di/dt = 100A/\mu s$ ④ ⑦                                                                                                                             |
| $t_{on}$ | Forward Turn-On Time                   | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$ ) |      |      |       |                                                                                                                                                      |

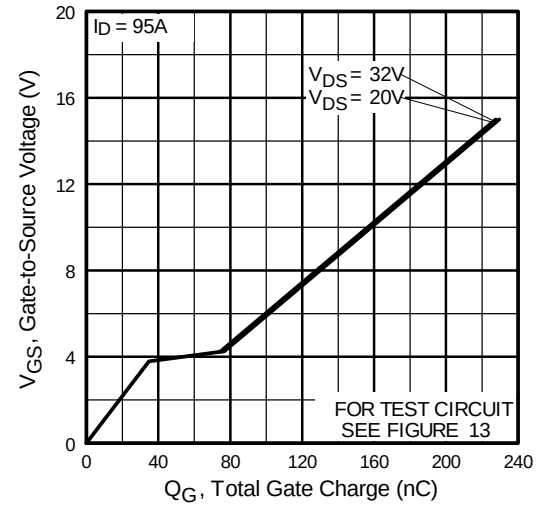
**Notes:**

- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11)
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.12mH$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 95A$ ,  $V_{GS} = 10V$ . (See fig. 12)
- ③  $I_{SD} \leq 95A$ ,  $di/dt \leq 150A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 175^\circ\text{C}$ .
- ④ Pulse width  $\leq 300\mu s$ ; duty cycle  $\leq 2\%$ .
- ⑤  $C_{oss\text{ eff.}}$  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 Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 75A.
- ⑦ Use IRF1404 data and test conditions.
- ⑧ This is applied to D<sup>2</sup>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 measured at  $T_J$  approximately  $90^\circ\text{C}$ .

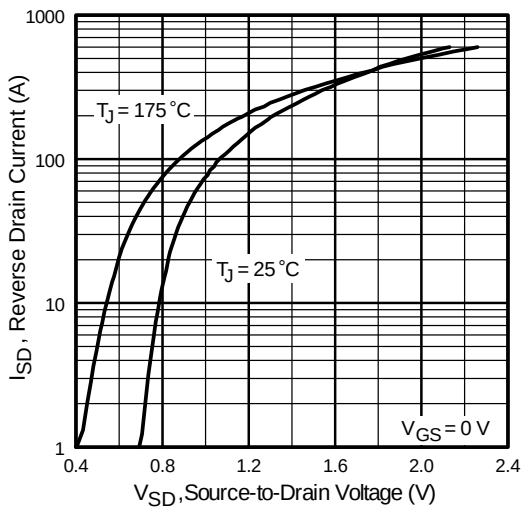




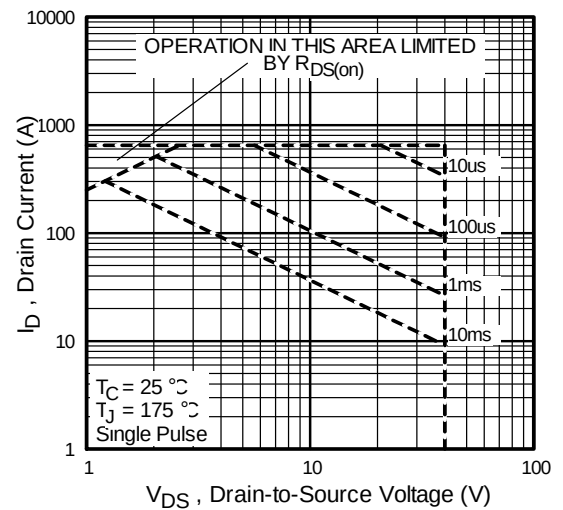
**Fig 5.** Typical Capacitance vs.  
Drain-to-Source Voltage



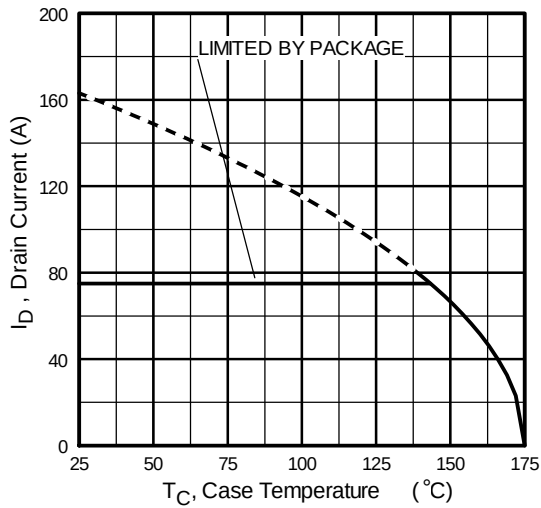
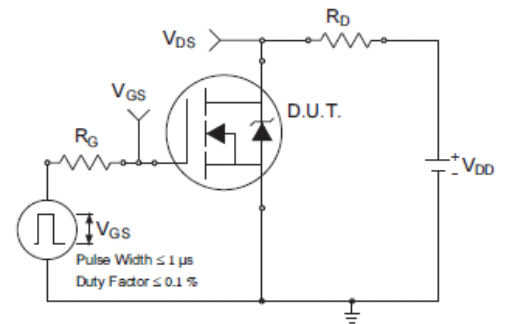
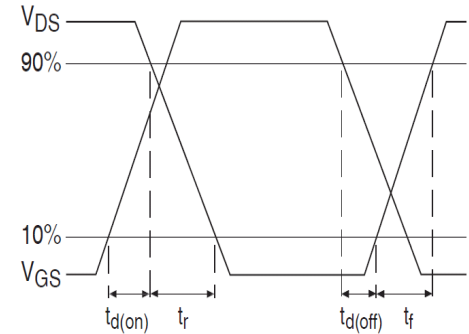
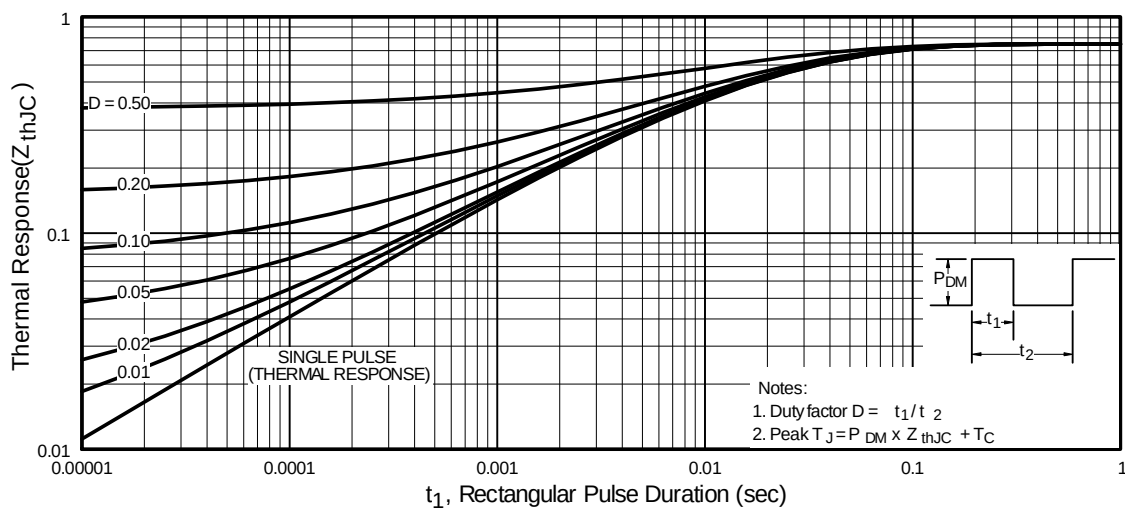
**Fig 6.** Typical Gate Charge vs.  
Gate-to-Source Voltage

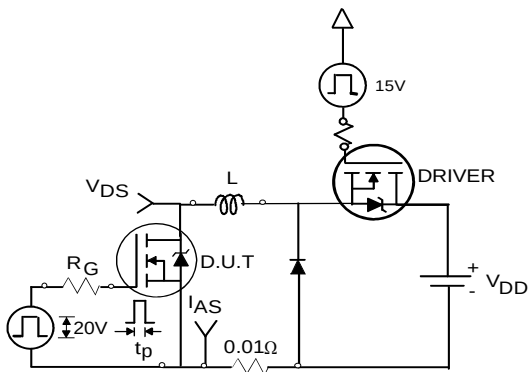
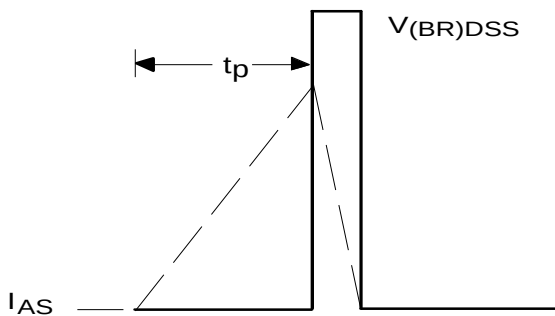
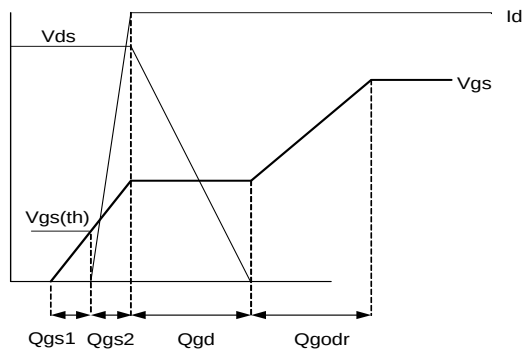
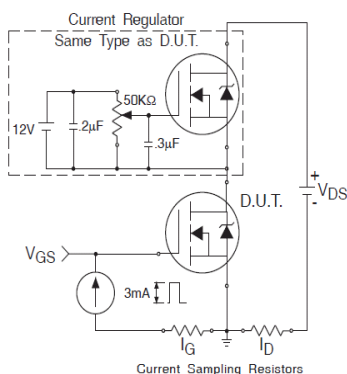
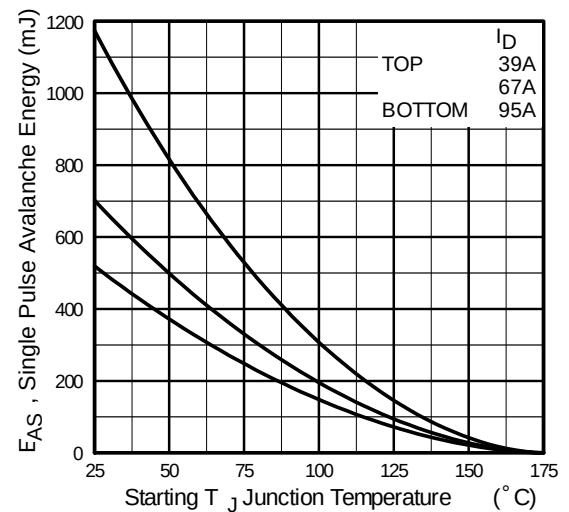
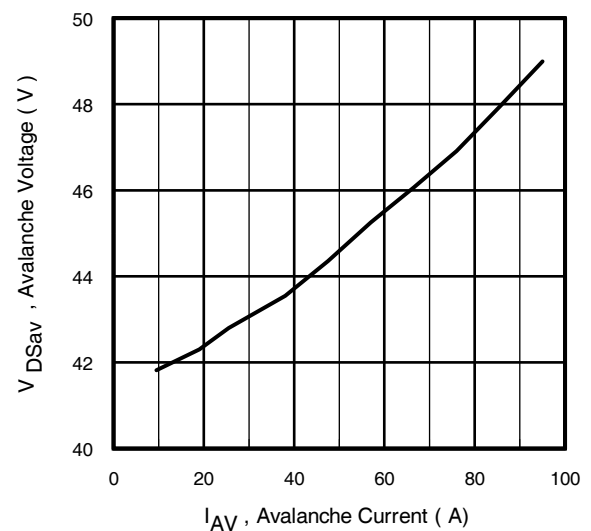


**Fig. 7** Typical Source-to-Drain Diode  
Forward Voltage

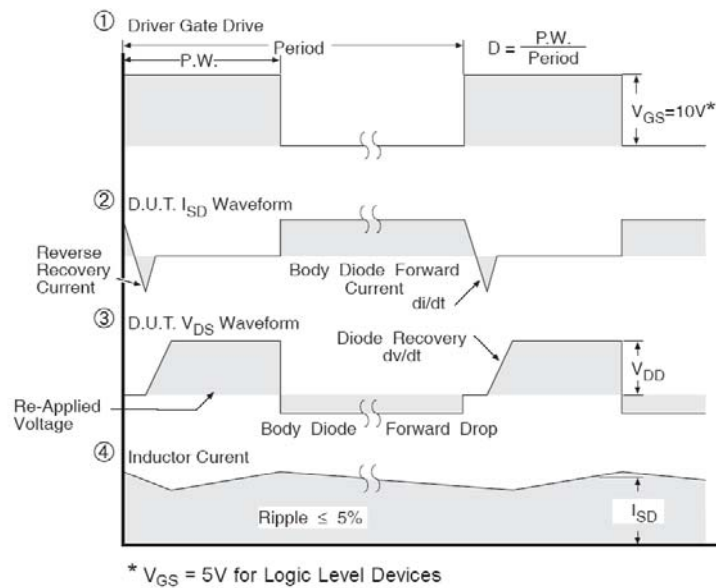
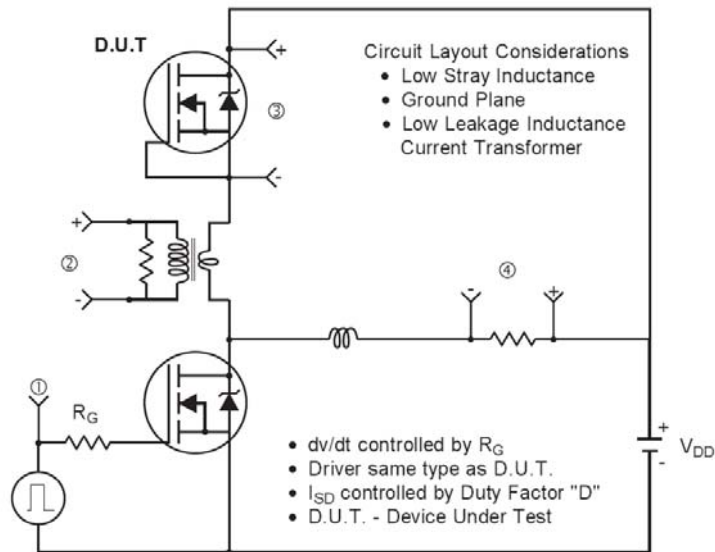


**Fig 8.** Maximum Safe Operating Area


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

**Fig 10a.** Switching Time Test Circuit

**Fig 10b.** Switching Time Waveforms

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

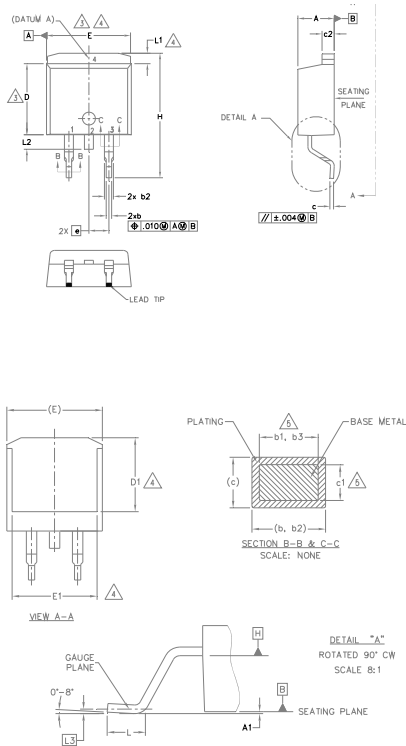

**Fig 12a.** Unclamped Inductive Test Circuit

**Fig 12b.** Unclamped Inductive Waveforms

**Fig 13a.** Gate Charge Waveform

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

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

**Fig 12d.** Typical Drain-to-Source Voltage Vs. Avalanche Current

# Peak Diode Recovery dv/dt Test Circuit



**Fig 14.** Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs

## 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, b3 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 | 5     |
| 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 | 5     |
| c      | 0.38        | 0.74  | .015     | .029 | 5     |
| c1     | 0.38        | 0.58  | .015     | .023 |       |
| 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 |      | 4     |
| H      | 14.61       | 15.88 | .575     | .625 |       |
| L      | 1.78        | 2.79  | .070     | .110 |       |
| L1     | —           | 1.68  | —        | .066 |       |
| L2     | —           | 1.78  | —        | .070 |       |
| L3     | 0.25 BSC    |       | .010 BSC |      |       |

### LEAD ASSIGNMENTS

#### DIODES

- 1.- ANODE (TWO DIE) / OPEN (ONE DIE)
- 2.- CATHODE
- 3.- ANODE

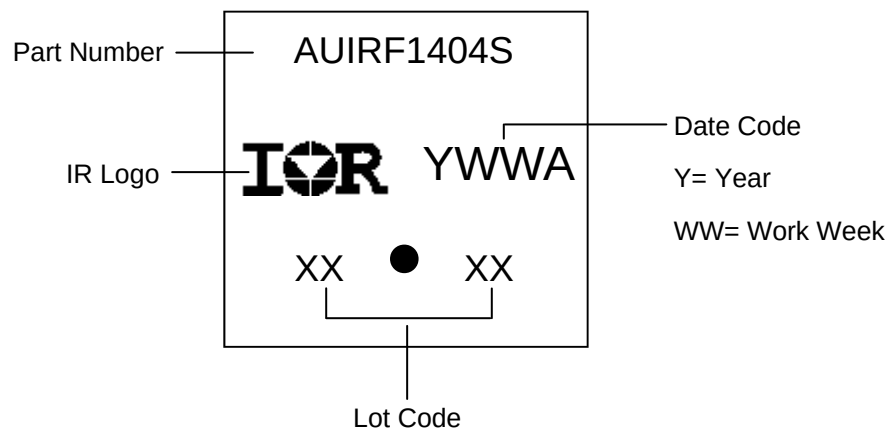
#### HEXFET

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

#### IGBTs, CoPACK

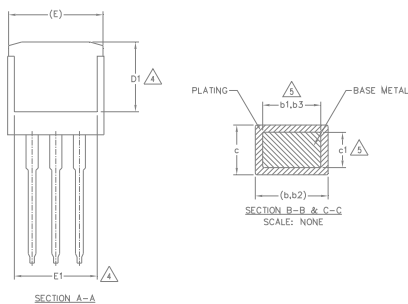
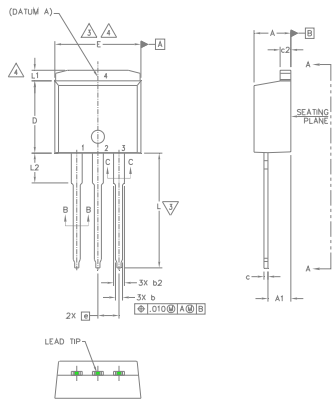
- 1.- GATE
- 2, 4.- COLLECTOR
- 3.- EMITTER

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





## 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.

### LEAD ASSIGNMENTS

#### IGBTs, CoPACK

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

#### HEXFET

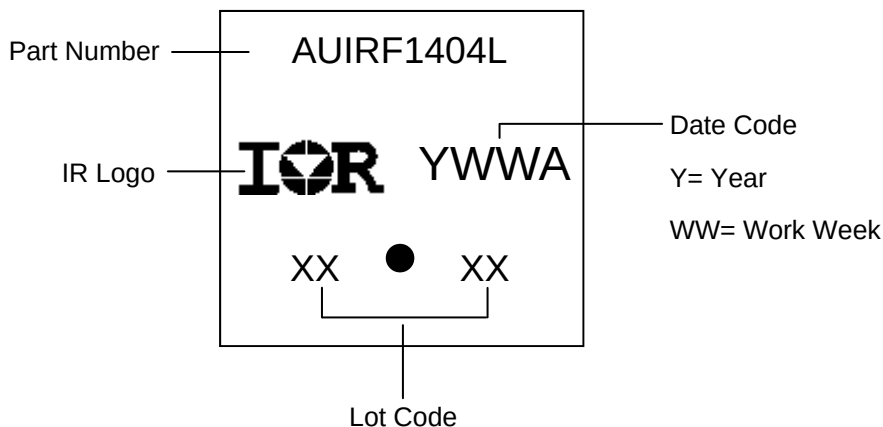
- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

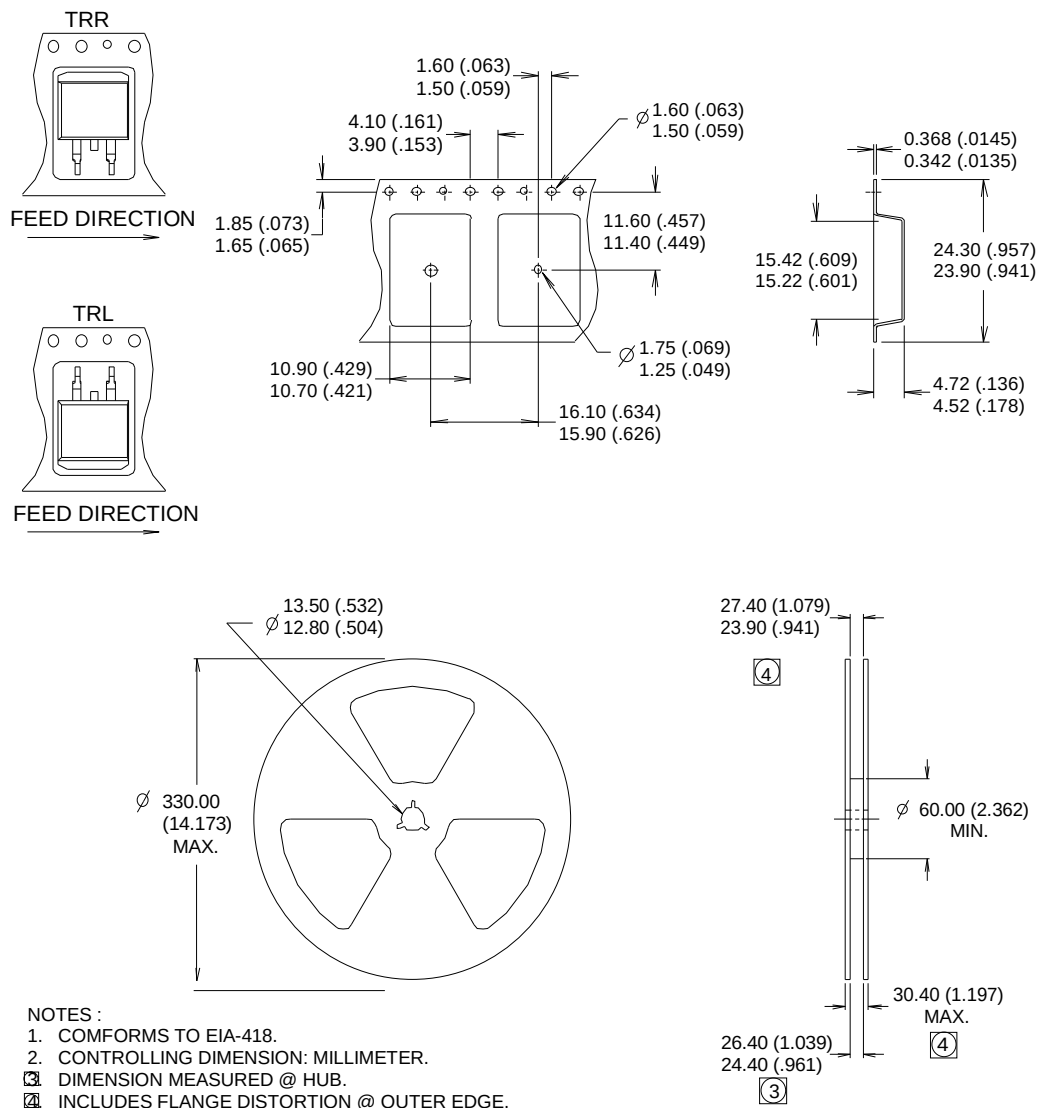
#### DIODES

- 1.- ANODE (TWO DIE) / OPEN (ONE DIE)
- 2, 4.- CATHODE
- 3.- ANODE

| SYM<br>BOL | DIMENSIONS  |       |          |      | NOTES |
|------------|-------------|-------|----------|------|-------|
|            | MILLIMETERS |       | INCHES   |      |       |
|            | MIN.        | MAX.  | MIN.     | MAX. |       |
| A          | 4.06        | 4.83  | .160     | .190 | 5     |
| A1         | 2.03        | 3.02  | .080     | .119 |       |
| 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 | 5     |
| c          | 0.38        | 0.74  | .015     | .029 | 5     |
| 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 | 3,4   |
| E1         | 6.22        | —     | .245     | —    | 4     |
| e          | 2.54 BSC    |       | .100 BSC |      |       |
| L          | 13.46       | 14.10 | .530     | .555 | 4     |
| L1         | —           | 1.65  | —        | .065 |       |
| L2         | 3.56        | 3.71  | .140     | .146 |       |

## TO-262 Part Marking Information



**D<sup>2</sup>Pak (TO-263AB) Tape & Reel Information** (Dimensions are shown in millimeters (inches))


**Qualification Information**

|                            |                      |                                                                                                                                                                               |      |
|----------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Qualification Level        |                      | Automotive<br>(per AEC-Q101)                                                                                                                                                  |      |
|                            |                      | Comments: This part number(s) passed Automotive qualification. Infineon's Industrial and Consumer qualification level is granted by extension of the higher Automotive level. |      |
| Moisture Sensitivity Level |                      | TO-262                                                                                                                                                                        | MSL1 |
|                            |                      | D <sup>2</sup> -Pak                                                                                                                                                           |      |
| ESD                        | Machine Model        | Class M4 (+/- 425V) <sup>†</sup><br>AEC-Q101-002                                                                                                                              |      |
|                            | Human Body Model     | Class H2 (+/- 4000V) <sup>†</sup><br>AEC-Q101-001                                                                                                                             |      |
|                            | Charged Device Model | Class C5 (+/-1125V) <sup>†</sup><br>AEC-Q101-005                                                                                                                              |      |
| RoHS Compliant             |                      | Yes                                                                                                                                                                           |      |

† Highest passing voltage.

**Revision History**

| Date       | Comments                                                                                                                                 |
|------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 11/11/2015 | <ul style="list-style-type: none"> <li>Updated datasheet with corporate template</li> <li>Corrected ordering table on page 1.</li> </ul> |

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