

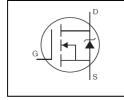
#### **AUTOMOTIVE GRADE**

# AUIRF1404Z AUIRF1404ZS AUIRF1404ZL

HEXFET® Power MOSFET

#### **Features**

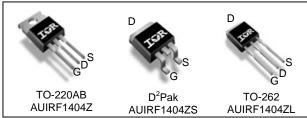
- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- · Repetitive Avalanche Allowed up to Tjmax
- Lead-Free, RoHS Compliant
- Automotive Qualified \*



V <sub>DSS</sub>	40V
R <sub>DS(on)</sub> max.	3.7m $Ω$
D (Silicon Limited)	180A <b>●</b>
D (Package Limited)	160A

# 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.



G	D	S
Gate	Drain	Source

Base next number	Deelsege Type	Standard Pack		Ordershie Port Number
Base part number	Package Type	Form	Quantity	Orderable Part Number
AUIRF1404Z	TO-220	Tube	50	AUIRF1404Z
AUIRF1404ZL	TO-262	Tube	50	AUIRF1404ZL
ALUDE440470	D <sup>2</sup> -Pak	Tube	50	AUIRF1404ZS
AUIRF1404ZS		Tape and Reel Left	800	AUIRF1404ZSTRL

#### **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 (TA) is 25°C, unless otherwise specified.

Symbol	Parameter	Max.	Units
I <sub>D</sub> @ T <sub>C</sub> = 25°C	Continuous Drain Current, V <sub>GS</sub> @ 10V (Silicon Limited)	180❶	
$I_D @ T_C = 100^{\circ}C$	Continuous Drain Current, V <sub>GS</sub> @ 10V (Silicon Limited)	120	] ,
$I_D @ T_C = 25^{\circ}C$	Continuous Drain Current, V <sub>GS</sub> @ 10V (Package Limited)	160	A
I <sub>DM</sub>	Pulsed Drain Current ①	710	1
$P_D @ T_C = 25^{\circ}C$	Maximum Power Dissipation	200	W
	Linear Derating Factor	1.3	W/°C
V <sub>GS</sub> Gate-to-Source Voltage		± 20	V
E <sub>AS</sub>			m l
E <sub>AS</sub> (tested)	Single Pulse Avalanche Energy Tested Value ®	480	- mJ
I <sub>AR</sub>	Avalanche Current ①	See Fig.15,16, 12a, 12b	Α
E <sub>AR</sub>	Repetitive Avalanche Energy ©		mJ
$T_J$	Operating Junction and	-55 to + 175	
T <sub>STG</sub> Storage Temperature Range			°C
	Soldering Temperature, for 10 seconds (1.6mm from case)	300	1
	Mounting torque, 6-32 or M3 screw ⑦	10 lbf•in (1.1N•m)	

#### Thermal Resistance

Symbol	Parameter	Тур.	Max.	Units
$R_{ heta JC}$	Junction-to-Case ®		0.759	
R <sub>ecs</sub> Case-to-Sink, Flat, Greased Surface ⑦		0.50		900
$R_{ hetaJA}$			62	°C/W
$R_{ hetaJA}$	Junction-to-Ambient ( PCB Mount, steady state) ®		40	

HEXFET® is a registered trademark of Infineon.

<sup>\*</sup>Qualification standards can be found at www.infineon.com



#### Static @ T<sub>J</sub> = 25°C (unless otherwise specified)

	Parameter	Min.	Тур.	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		0.033		V/°C	Reference to 25°C, I <sub>D</sub> = 1mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-Resistance		2.7	3.7	mΩ	$V_{GS} = 10V, I_D = 75A$ ③
$V_{GS(th)}$	Gate Threshold Voltage	2.0		4.0	V	$V_{DS} = V_{GS}$ , $I_D = 250\mu A$
gfs	Forward Trans conductance	170			S	$V_{DS} = 25V, I_{D} = 75A$
ı	Drain-to-Source Leakage Current			20		$V_{DS} = 40 \text{ V}, V_{GS} = 0 \text{ V}$
IDSS	Drain-to-Source Leakage Current			250	μA	$V_{DS} = 40V, V_{GS} = 0V, T_{J} = 125^{\circ}C$
	Gate-to-Source Forward Leakage — 200		200	- A	$V_{GS} = 20V$	
I <sub>GSS</sub>	Gate-to-Source Reverse Leakage			-200		$V_{GS} = -20V$

#### Dynamic Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

$Q_g$	Total Gate Charge		100	150		I <sub>D</sub> = 75A
$Q_{gs}$	Gate-to-Source Charge		31		nC	$V_{DS} = 32V$
$Q_{gd}$	Gate-to-Drain Charge		42			V <sub>GS</sub> = 10V3
t <sub>d(on)</sub>	Turn-On Delay Time		18			$V_{DD} = 20V$
t <sub>r</sub>	Rise Time		110		20	$I_D = 75A$
$t_{d(off)}$	Turn-Off Delay Time		36		ns	$R_G = 3.0\Omega$
t <sub>f</sub>	Fall Time		58			V <sub>GS</sub> = 10V ③
$L_D$	Internal Drain Inductance		4.5			Between lead, 6mm (0.25in.)
L <sub>S</sub>	Internal Source Inductance		7.5			from package and center of die contact
C <sub>iss</sub>	Input Capacitance	<u> </u>	4340			$V_{GS} = 0V$
C <sub>oss</sub>	Output Capacitance		1030			$V_{DS} = 25V$
$C_{rss}$	Reverse Transfer Capacitance		550		~_	f = 1.0MHz
C <sub>oss</sub>	Output Capacitance		3300		pF	$V_{GS} = 0V, V_{DS} = 1.0V f = 1.0MHz$
Coss	Output Capacitance		920			$V_{GS} = 0V$ , $V_{DS} = 32V$ $f = 1.0MHz$
C <sub>oss eff.</sub>	Effective Output Capacitance		1350			$V_{GS} = 0V, V_{DS} = 0V \text{ to } 32V  $

#### **Diode Characteristics**

	Parameter	Min.	Тур.	Max.	Units	Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)			160		MOSFET symbol showing the
I <sub>SM</sub>	Pulsed Source Current (Body Diode) ①			750	A	integral reverse p-n junction diode.
$V_{SD}$	Diode Forward Voltage			1.3		$T_J = 25^{\circ}C, I_S = 75A, V_{GS} = 0V$ ③
t <sub>rr</sub>	Reverse Recovery Time		28	42	ns	$T_J = 25^{\circ}C$ , $I_F = 75A$ , $V_{DD} = 20V$
$Q_{rr}$	Reverse Recovery Charge		34	51	nC	di/dt = 100A/µs ③
t <sub>on</sub>	Forward Turn-On Time	Intrinsio	Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> +L <sub>D</sub> )			

#### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11)
- ② Limited by  $T_{Jmax}$ , starting  $T_J = 25^{\circ}C$ , L = 0.11mH,  $R_G = 25\Omega$ ,  $I_{AS} = 75$ A,  $V_{GS} = 10$ V. Part not recommended for use above this value.
- $\oplus$  C<sub>oss</sub> eff. is a fixed capacitance that gives the same charging time as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V<sub>DSS</sub>.
- © Limited by T<sub>Jmax</sub>, see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.
- © This value determined from sample failure population, starting  $T_J = 25$ °C, L = 0.11mH,  $R_G = 25$ Ω,  $I_{AS} = 75$ A,  $V_{GS} = 10$ V.
- This is only applied to TO-220AB pakcage.
- 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 TO-220 device will have an Rth value of 0.65°C/W.
- Calculated continuous current based on maximum allowable junction temperature. Package limitation current limit is 160A.
   Note that current limitations arising from heating of the device leads may occur with some lead mounting arrangements.
   (Refer to AN-1140)



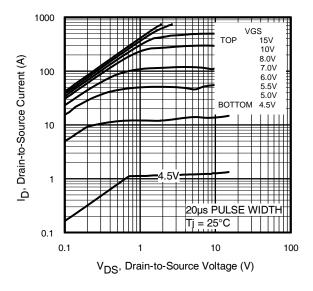


Fig. 1 Typical Output Characteristics

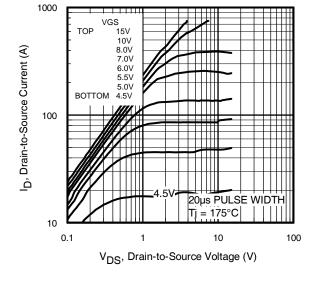


Fig. 2 Typical Output Characteristics

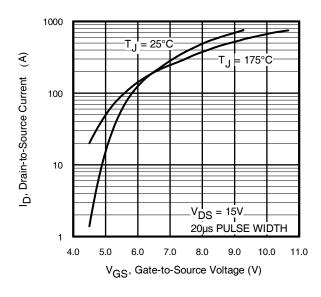


Fig. 3 Typical Transfer Characteristics

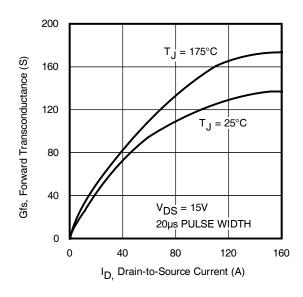
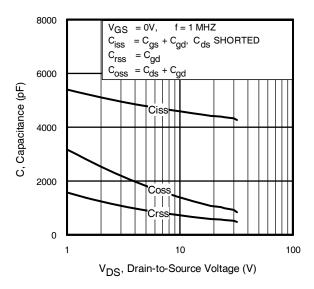
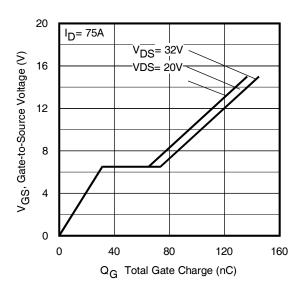


Fig. 4 Typical Forward Trans conductance vs. Drain Current





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



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

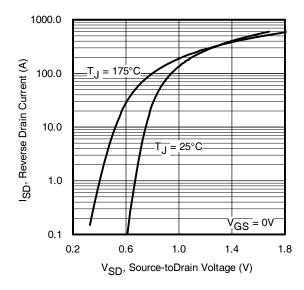


Fig. 7 Typical Source-to-Drain Diode Forward Voltage

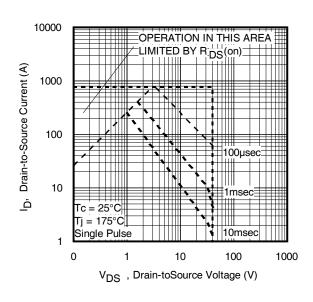
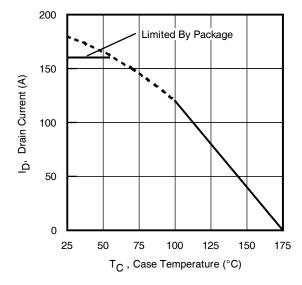


Fig 8. Maximum Safe Operating Area





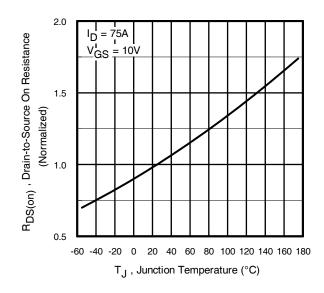


Fig 9. Maximum Drain Current vs. Case Temperature

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

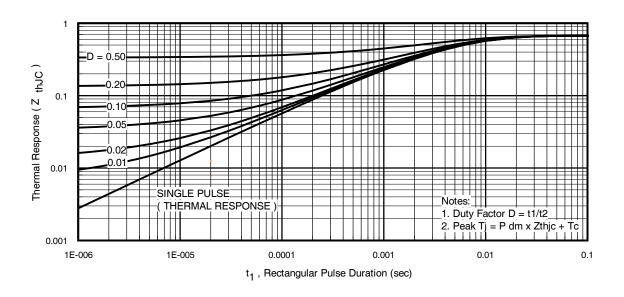


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case



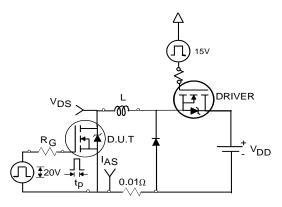


Fig 12a. Unclamped Inductive Test Circuit

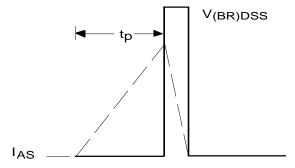


Fig 12b. Unclamped Inductive Waveforms

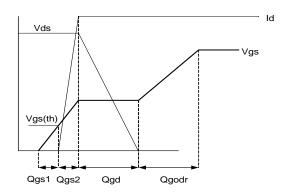


Fig 13a. Gate Charge Waveform

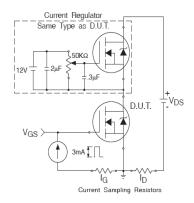
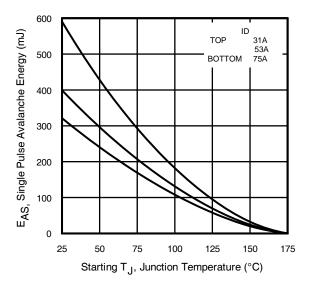
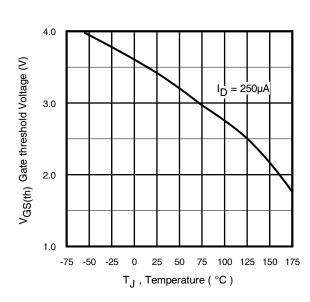


Fig 13b. Gate Charge Test Circuit



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



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



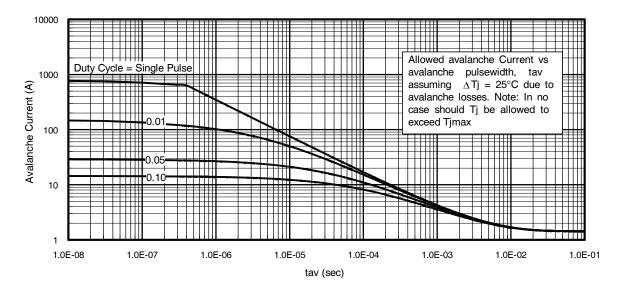
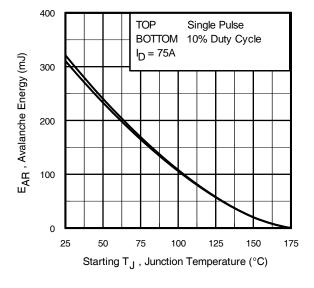


Fig 15. Typical Avalanche Current vs. Pulse width



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

Notes on Repetitive Avalanche Curves , Figures 15, 16: (For further info, see AN-1005 at www.infineon.com)

- Avalanche failures assumption:
  - Purely a thermal phenomenon and failure occurs at a temperature far in excess of T<sub>jmax</sub>. This is validated for every part type.
- Safe operation in Avalanche is allowed as long as T<sub>jmax</sub> is not exceeded.
- 3. Equation below based on circuit and waveforms shown in Figures 12a, 12b.
- 4. PD (ave) = Average power dissipation per single avalanche pulse.
- BV = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
- 6. Iav = Allowable avalanche current.
- 7.  $\Delta T$  = Allowable rise in junction temperature, not to exceed  $T_{jmax}$  (assumed as 25°C in Figure 15, 16).

tav = Average time in avalanche.

D = Duty cycle in avalanche = tav ·f

ZthJC(D, tav) = Transient thermal resistance, see Figures 13)

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



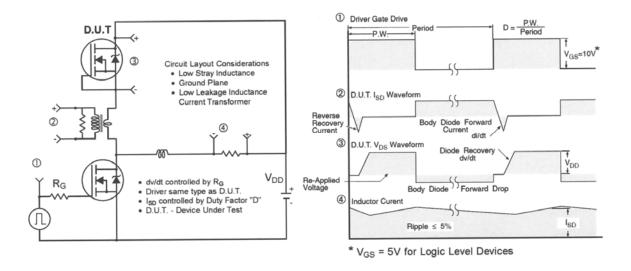


Fig 17. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

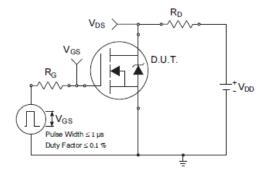


Fig 18a. Switching Time Test Circuit

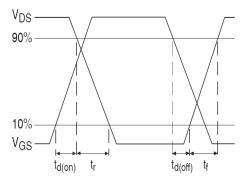
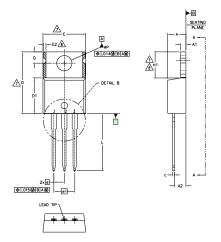
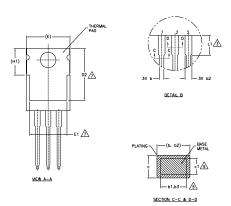


Fig 18b. Switching Time Waveforms



### TO-220AB Package Outline (Dimensions are shown in millimeters (inches))





#### NOTES:

- DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M- 1994.

- DIMENSIONING AND TOLERANGING AS PER ASMETTA, SWITTA, S MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.

DIMENSION 61, 63 & c1 APPLY TO BASE METAL ONLY.

- CONTROLLING DIMENSION: INCHES.
- THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
- DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
- OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

SYMBOL	MILLIMETERS		INC	HES	
	MIN.	MAX.	MIN.	MAX.	NOTES
A	3.56	4.83	.140	.190	
A1	1,14	1.40	.045	.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
С	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	2.54 BSC		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
ØΡ	3.54	4.08	.139	.161	
Q	2.54	3.42	.100	.135	

#### LEAD ASSIGNMENTS

#### HEXFET

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

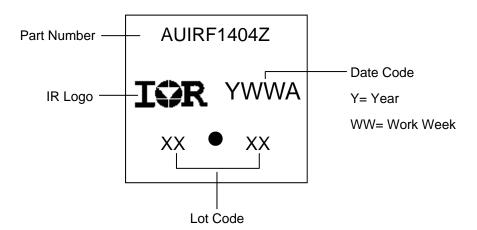
#### IGBTs, CoPACK

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

# DIODES

- 1.- ANODE 2.- CATHODE 3.- ANODE

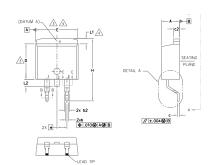
## **TO-220AB Part Marking Information**

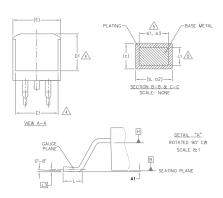


TO-220AB package is not recommended for Surface Mount Application.



# D<sup>2</sup>Pak (TO-263AB) Package Outline (Dimensions are shown in millimeters (inches))





- 1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
- 2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].

AT THE OUTMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.

4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.

5. DIMENSION 61, 63 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.

S Y M		DIMENSIONS				
B	MILLIM	ETERS	INC	HES	O T E S	
L	MIN.	MAX.	MIN.	MAX.	S	
А	4.06	4.83	.160	.190		
A1	0.00	0.254	.000	.010		
ь	0.51	0.99	.020	.039		
ь1	0.51	0.89	.020	.035	5	
b2	1.14	1.78	.045	.070		
b3	1.14	1.73	.045	.068	5	
С	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	
е	2.54	BSC	.100	BSC		
Н	14.61	15.88	.575	.625		
L	1.78	2.79	.070	.110		
L1	_	1.68	_	.066	4	
L2	_	1.78	_	.070		
L3	0.25	BSC	.010	BSC		

#### LEAD ASSIGNMENTS

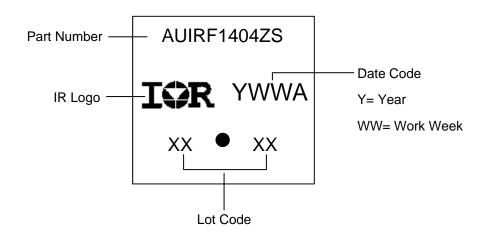
#### DIODES

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

#### HEXFET

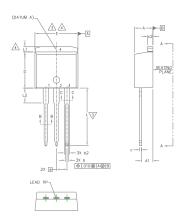
IGBTs, CoPACK 1.- GATE 2, 4.- DRAIN 3.- SOURCE 2, 4.- COLLECTOR 3.- EMITTER

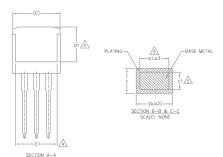
# D<sup>2</sup>Pak (TO-263AB) Part Marking Information





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





- 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.
- 4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
- 5. DIMENSION 61 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

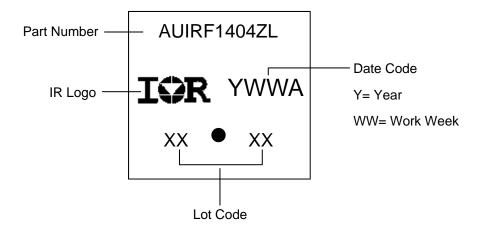
#### HEXFET DIODES

1.- GATE

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

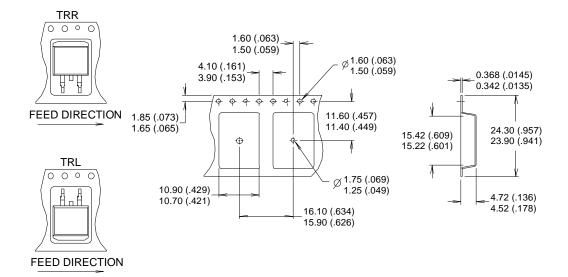
S Y M		DIMENSIONS				
B	MILLIN	IETERS	INC	HES	N O T E S	
L	MIN.	MAX.	MIN.	MAX.	S	
А	4.06	4.83	.160	.190		
A1	2.03	3.02	.080	.119		
b	0.51	0.99	.020	.039		
b1	0.51	0.89	.020	.035	5	
b2	1.14	1.78	.045	.070		
ь3	1.14	1.73	.045	.068	5	
С	0.38	0.74	.015	.029		
c1	0.38	0.58	.015	.023	5	
c2	1.14	1.65	.045	.065		
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	
е	2.54	BSC	.100	BSC		
L	13.46	14.10	.530	.555		
L1	_	1.65	-	.065	4	
L2	3.56	3.71	.140	.146		

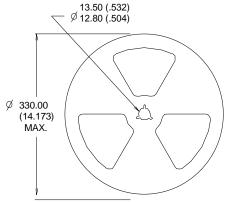
## **TO-262 Part Marking Information**





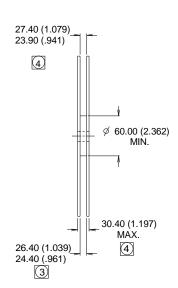
# D<sup>2</sup>Pak (TO-263AB) Tape & Reel Information (Dimensions are shown in millimeters (inches))







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





#### **Qualification Information**

Automotive			Automotivo			
Qualification Level		(per AEC-Q101)				
			is part number(s) passed Automotive qualification. Infineon's consumer qualification level is granted by extension of the higher el.			
		TO-220AB	N/A			
Moisture	Moisture Sensitivity Level		MOL 4			
			MSL1			
	Machine Madel	Class M4 <sup>†</sup>				
	Machine Model	AEC-Q101-002				
ECD	Lluman Dady Madal		Class H1C <sup>†</sup>			
ESD	Human Body Model	AEC-Q101-001				
	Oleman I Davis a Martal	Class C3 <sup>†</sup>				
Charged Device Model		AEC-Q101-005				
RoHS Compliant Yes		Yes				

<sup>†</sup> Highest passing voltage.

#### **Revision History**

Date	Comments
11/11/2015	Updated datasheet with corporate template
	Corrected ordering table on page 1.

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