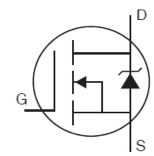
AUTOMOTIVE GRADE

AUIRL1404Z
AUIRL1404ZS
AUIRL1404ZL

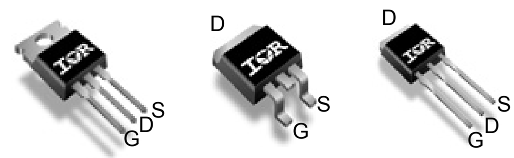
HEXFET® Power MOSFET

Features

- Logic Level
- 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_{DSS}		**40V**
$R_{DS(on)}$	typ.	**2.5mΩ**
	max.	**3.1mΩ**
I_D (Silicon Limited)		**180A⑩**
I_D (Package Limited)		**160A**



TO-220AB AUIRL1404Z

D^2Pak AUIRL1404ZS

TO-262 AUIRL1404ZL

G	D	S
Gate	Drain	Source

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.

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
AUIRL1404Z	TO-220	Tube	50	AUIRL1404Z
AUIRL1404ZL	TO-262	Tube	50	AUIRL1404ZL
AUIRL1404ZS	D^2-Pak	Tube	50	AUIRL1404ZS
		Tape and Reel Left	800	AUIRL1404ZSTRL

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_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)	180⑩	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)	130	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Package Limited)	160	
I_{DM}	Pulsed Drain Current ①	790	
P_D @T_C = 25°C	Maximum Power Dissipation	200	W
	Linear Derating Factor	1.3	W/°C
V_{GS}	Gate-to-Source Voltage	± 16	V
E_{AS}	Single Pulse Avalanche Energy (Thermally Limited) ②	190	mJ
E_{AS} (tested)	Single Pulse Avalanche Energy Tested Value ⑥	490	
I_{AR}	Avalanche Current ①	See Fig.15,16, 12a, 12b	A
E_{AR}	Repetitive Avalanche Energy ⑤		mJ
T_J T_{STG}	Operating Junction and 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

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	——	0.75⑨	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface ⑦	0.50	——	
$R_{\theta JA}$	Junction-to-Ambient ⑦	——	62	
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount, steady state) ⑦		40	

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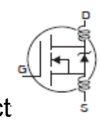
*Qualification standards can be found at www.infineon.com

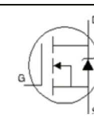
Static @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	40	——	——	V	V_{GS} = 0V, I_D = 250μA
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	——	0.034	——	V/°C	Reference to 25°C, I_D = 1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	——	2.5	3.1	mΩ	V_{GS} = 10V, I_D = 75A ③**
		——	——	4.7		V_{GS} = 5.0V, I_D = 40A ③
		——	——	5.9		VGS = 4.5V, ID = 40A ③
$V_{GS(th)}$	Gate Threshold Voltage	1.4	——	2.7	V	V_{DS} = V_{GS}, I_D = 250μA
gfs	Forward Trans conductance	120	——	——	S	V_{DS} = 10V, I_D = 75A**
I_{DSS}	Drain-to-Source Leakage Current	——	——	20	μA	V_{DS} = 40V, V_{GS} = 0V
		——	——	250		V_{DS} = 40V,V_{GS} = 0V,T_J =125°C
I_{GSS}	Gate-to-Source Forward Leakage	——	——	200	nA	V_{GS} = 16V
	Gate-to-Source Reverse Leakage	——	——	-200		V_{GS} = -16V

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge	——	75	110	nC	I_D = 75A**
Q_{gs}	Gate-to-Source Charge	——	28	——		V_{DS} = 32V
Q_{gd}	Gate-to-Drain Charge	——	40	——		V_{GS} = 5.0V③
$t_{d(on)}$	Turn-On Delay Time	——	19	——	ns	V_{DD} = 20V
t_r	Rise Time	——	180	——		I_D = 75A**
$t_{d(off)}$	Turn-Off Delay Time	——	30	——		R_G= 4.0Ω,
t_f	Fall Time	——	49	——		V_{GS} = 5.0V ③
L_D	Internal Drain Inductance	——	4.5	——	nH	Between lead, 6mm (0.25in.)
L_S	Internal Source Inductance	——	7.5	——		from package and center of die contact 
C_{iss}	Input Capacitance	——	5080	——	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	——	970	——		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	——	570	——		f = 1.0MHz
C_{oss}	Output Capacitance	——	3310	——		V_{GS} = 0V, V_{DS} = 1.0V f = 1.0MHz
C_{oss}	Output Capacitance	——	870	——		V_{GS} = 0V, V_{DS} = 32V f = 1.0MHz
$C_{oss\ eff.}$	Effective Output Capacitance	——	1280	——		V_{GS} = 0V, V_{DS} = 0V to 32V ④

Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	——	——	180	A	MOSFET symbol showing the
I_{SM}	Pulsed Source Current (Body Diode) ①	——	——	790		integral reverse p-n junction diode. 
V_{SD}	Diode Forward Voltage	——	——	1.3	V	T_J = 25°C,I_S = 75A**,V_{GS} = 0V ③
t_{rr}	Reverse Recovery Time	——	26	39	ns	T_J = 25°C ,I_F = 75A** , V_{DD} = 20V
Q_{rr}	Reverse Recovery Charge	——	18	27	nC	di/dt = 100A/μs ③
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 Limited by T_{Jmax}, starting T_J = 25°C, L = 0.066mH, R_G = 25Ω, I_{AS} = 75A, V_{GS} =10V. Part not recommended for use above this value.
③ Pulse width ≤ 1.0ms; duty cycle ≤ 2%.
④ 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}.
⑤ Limited by T_{Jmax} , see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.
⑥ This value determined from sample failure population 100% tested to this value in production.
⑦ This is only applied to TO-220AB package.
⑧ 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-220Pak device will have an Rth value of 0.65°C/W.
⑩ Calculated continuous current based on maximum allowable junction temperature. Bond wire current limit is 160A. Note that current l imitations arising from heating of the device leads may occur with some lead mounting arrangements.
** All AC and DC test conditions based on former package limited current of 75A.

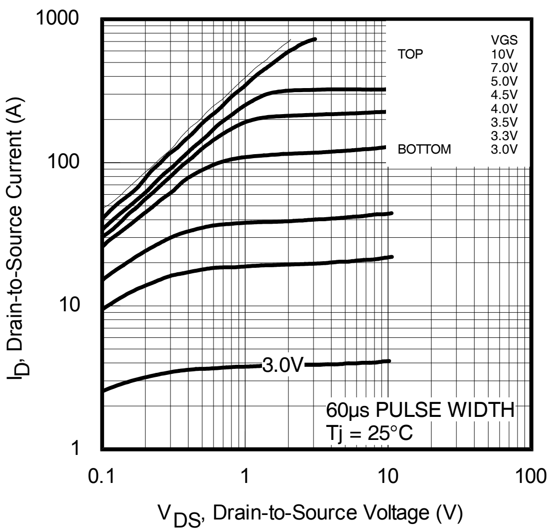


Fig. 1 Typical Output Characteristics

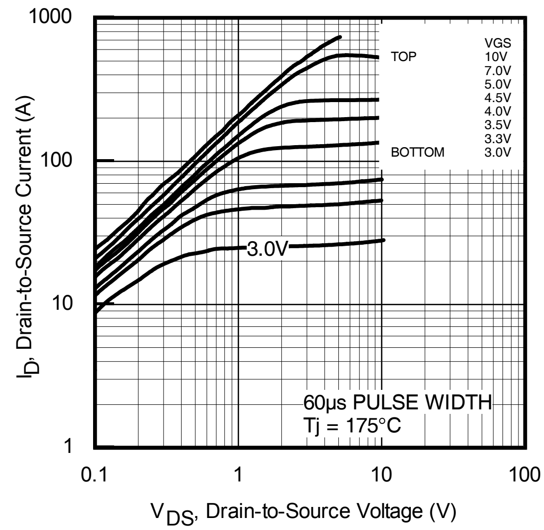


Fig. 2 Typical Output Characteristics

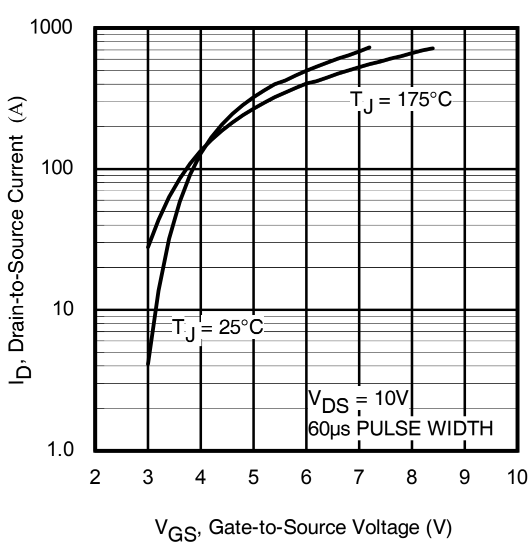


Fig. 3 Typical Transfer Characteristics

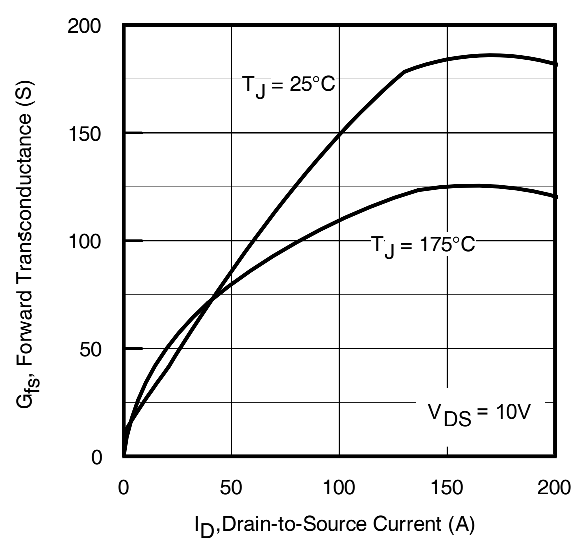


Fig. 4 Typical Forward Transconductance vs. Drain Current

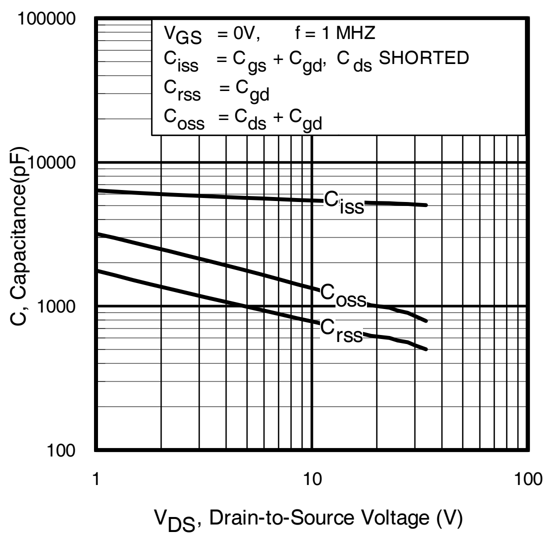


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

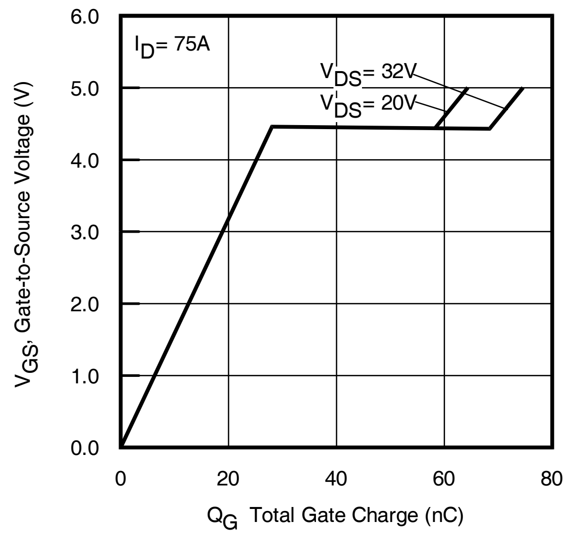


Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage

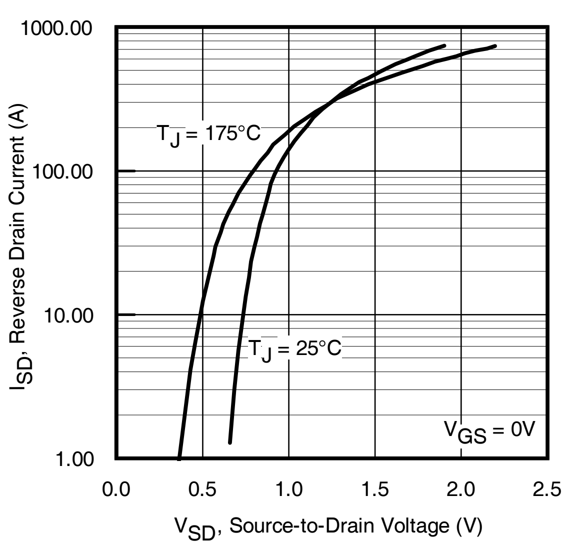


Fig. 7 Typical Source-to-Drain Diode Forward Voltage

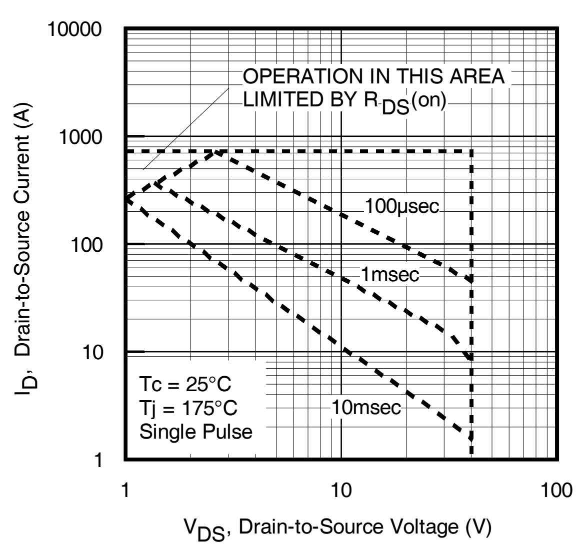


Fig 8. Maximum Safe Operating Area

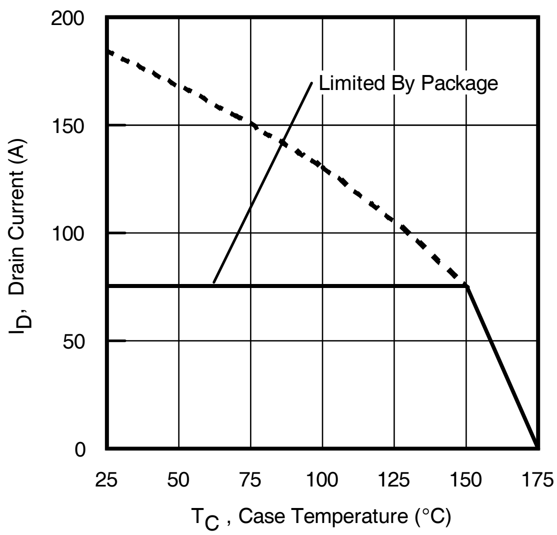


Fig 9. Maximum Drain Current vs. Case Temperature

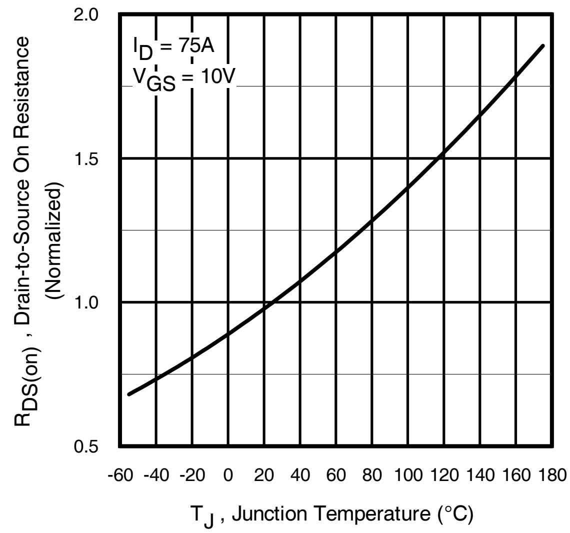
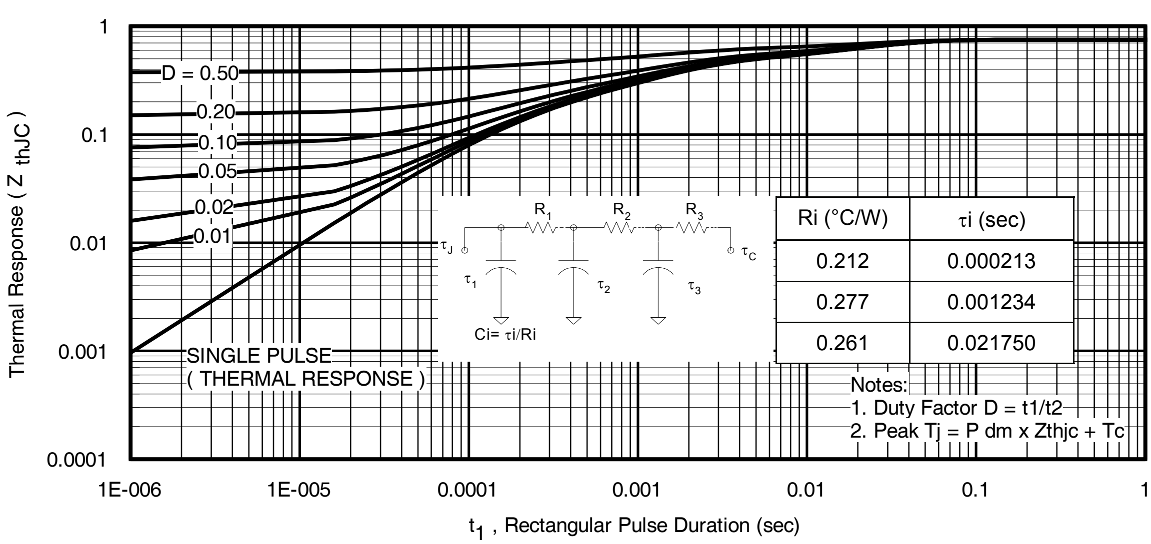


Fig 10. Normalized On-Resistance vs. Temperature



Ri (°C/W)	τi (sec)
0.212	0.000213
0.277	0.001234
0.261	0.021750

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

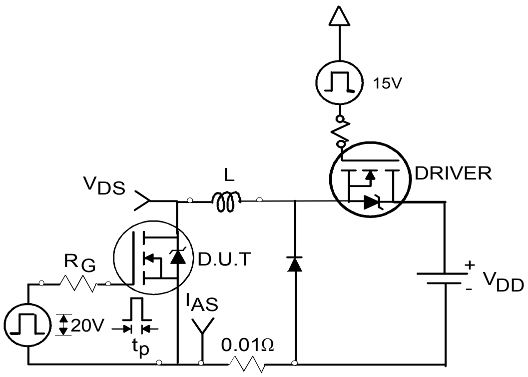


Fig 12a. Unclamped Inductive Test Circuit

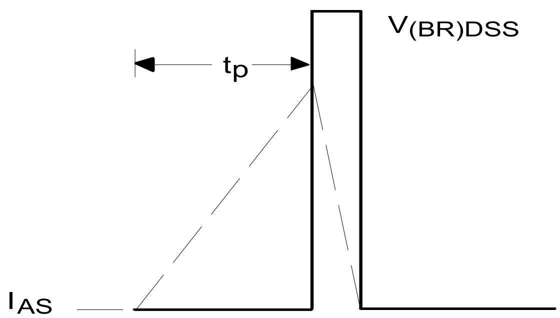


Fig 12b. Unclamped Inductive Waveforms

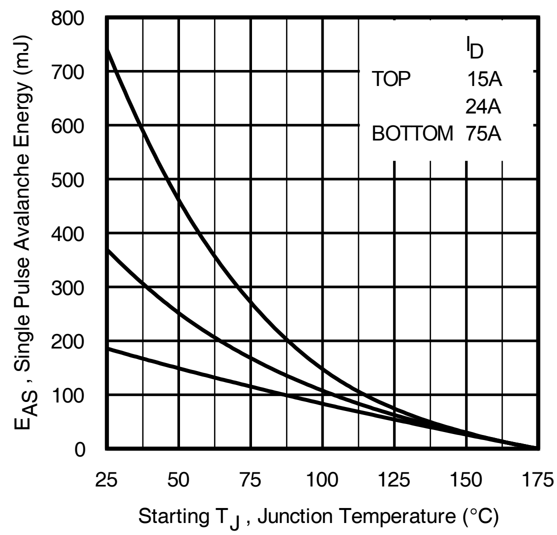


Fig 12c. Maximum Avalanche Energy vs. Drain Current

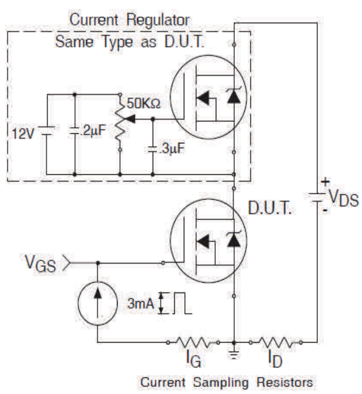


Fig 13a. Gate Charge Test Circuit

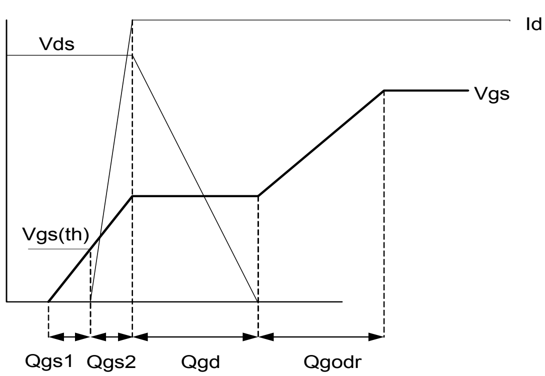


Fig 13b. Gate Charge Waveform

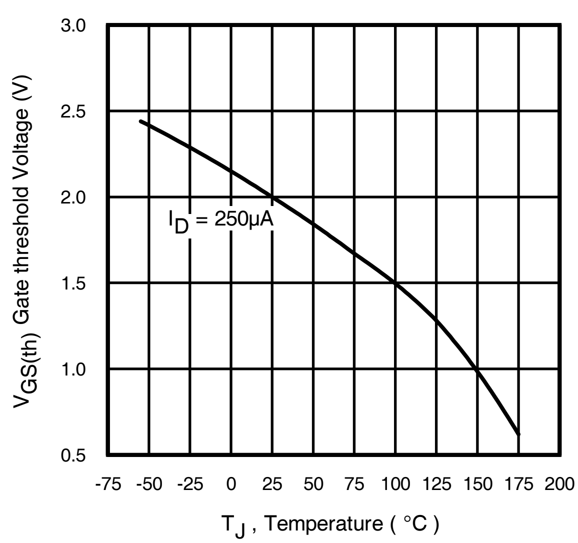


Fig 14. Threshold Voltage vs. Temperature

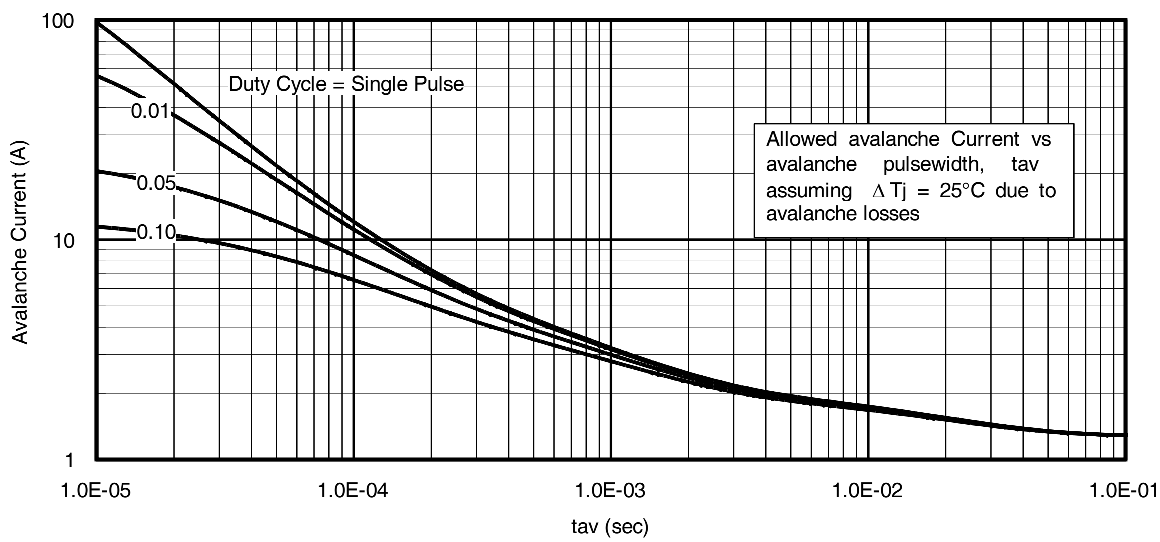
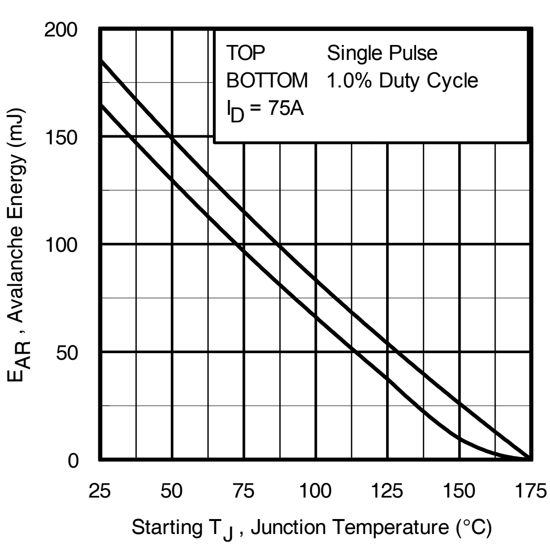


Fig 15. Avalanche Current vs. Pulse width



Notes on Repetitive Avalanche Curves , Figures 15, 16:
(For further info, see AN-1005 at www.infineon.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. ΔT = 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 16. Maximum Avalanche Energy vs. Temperature

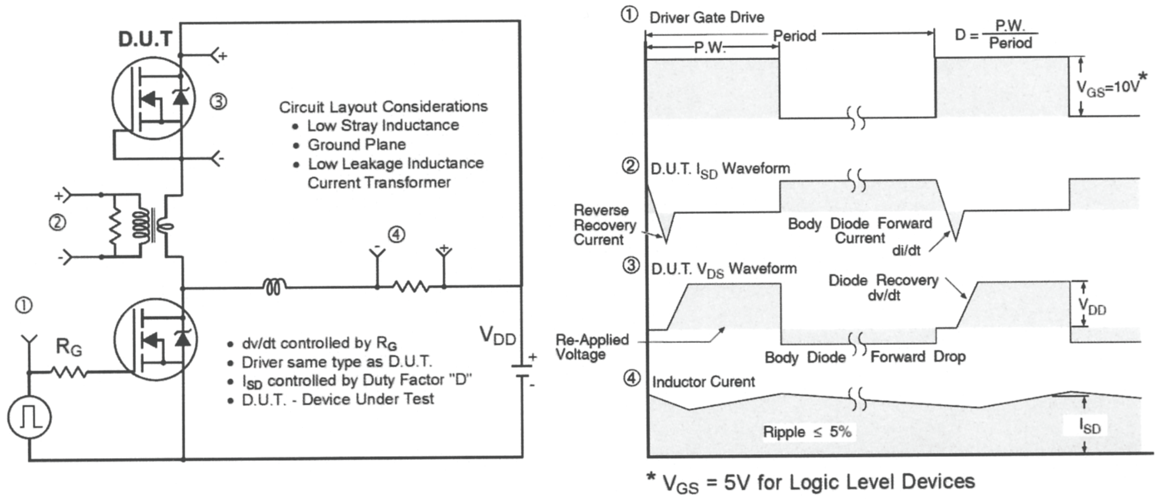


Fig 17. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

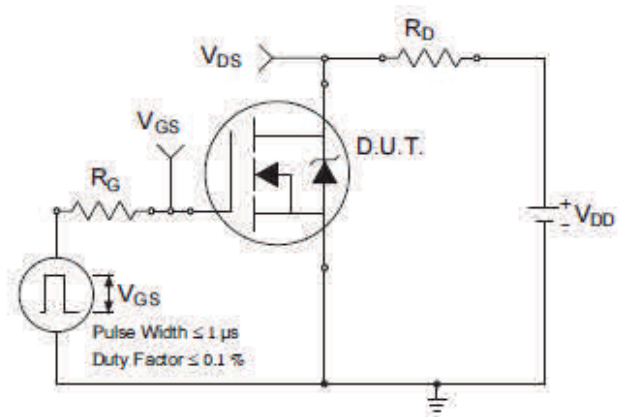


Fig 18a. Switching Time Test Circuit

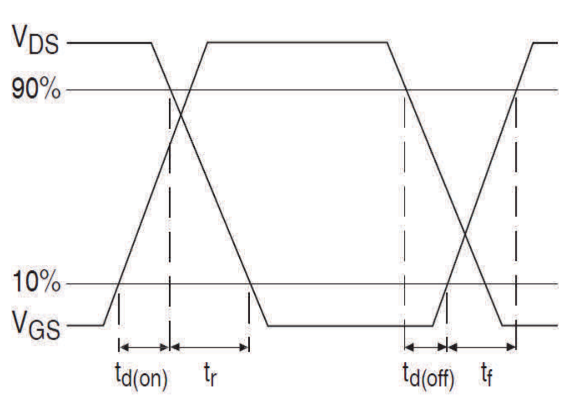
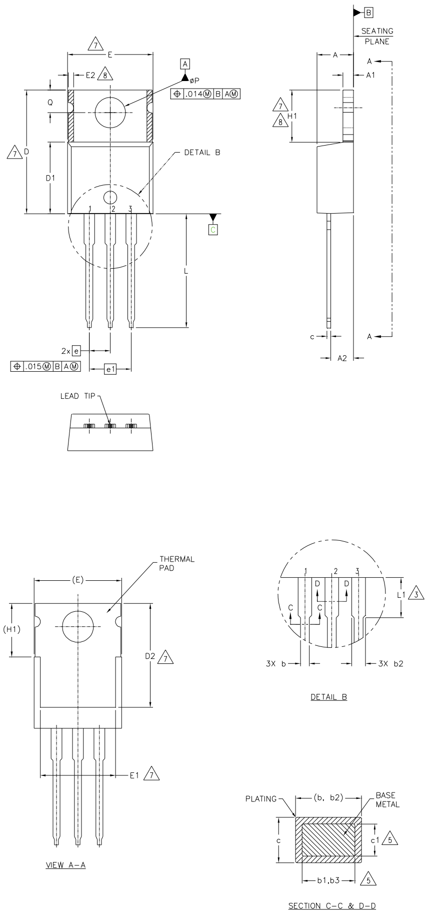


Fig 18b. Switching Time Waveforms

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	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
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

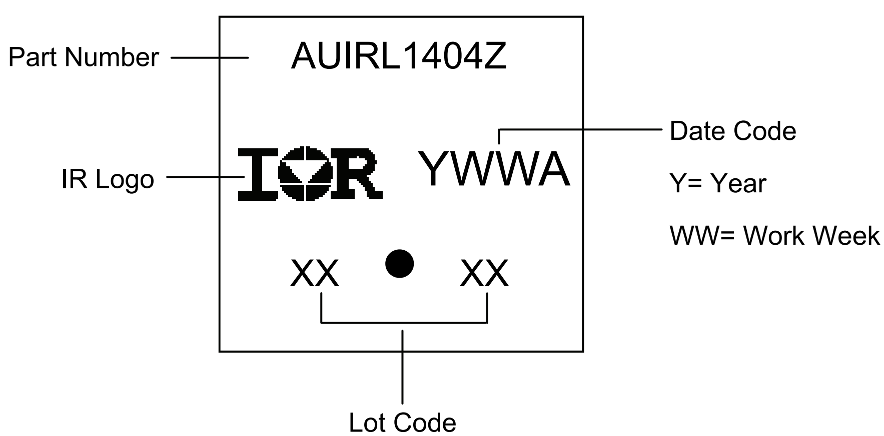
IGBTs, CoPACK

1.– GATE
2.– COLLECTOR
3.– EMITTER

DIODES

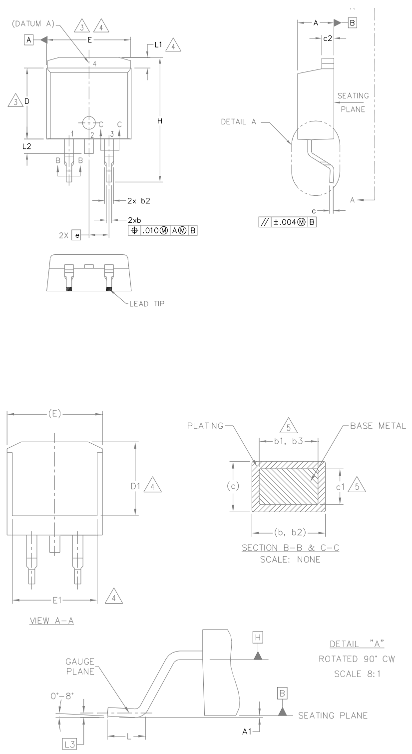
1.– ANODE
2.– CATHODE
3.– ANODE

TO-220AB Part Marking Information



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))



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, 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	
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	–	1.68	–	.066	4
L2	–	1.78	–	.070	
L3	0.25 BSC		.010 BSC		

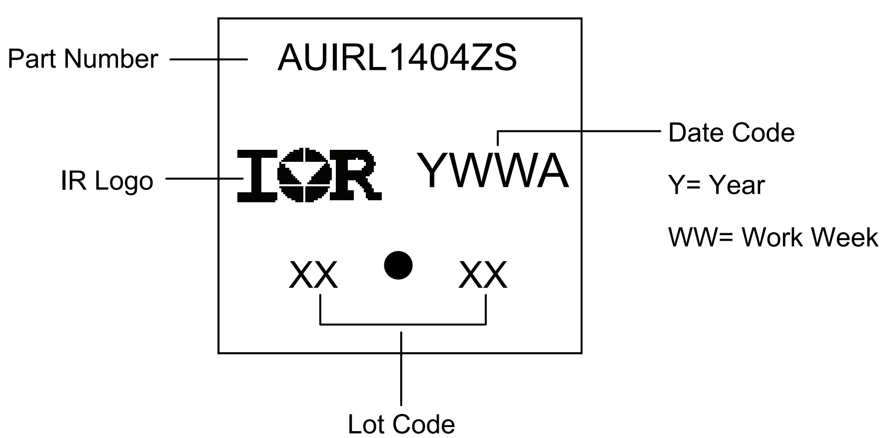
LEAD ASSIGNMENTS

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

HEXFET
1.– GATE
2, 4.– DRAIN
3.– SOURCE

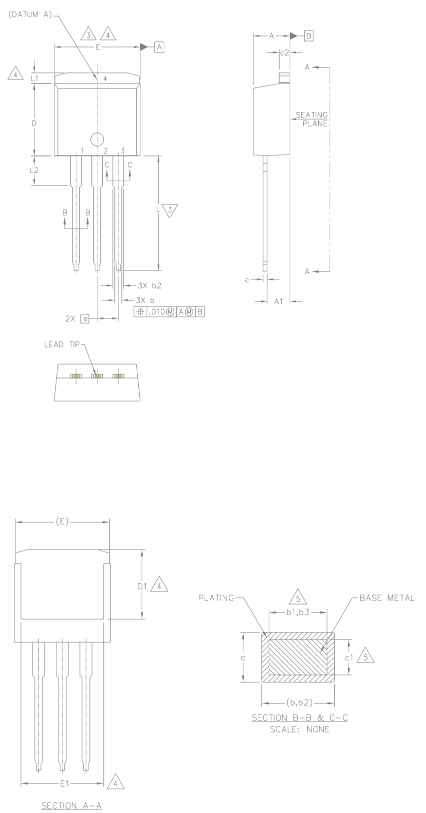
IGBTs, CoPACK
1.– GATE
2, 4.– COLLECTOR
3.– EMITTER

D²Pak (TO-263AB) Part Marking Information



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

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 [.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

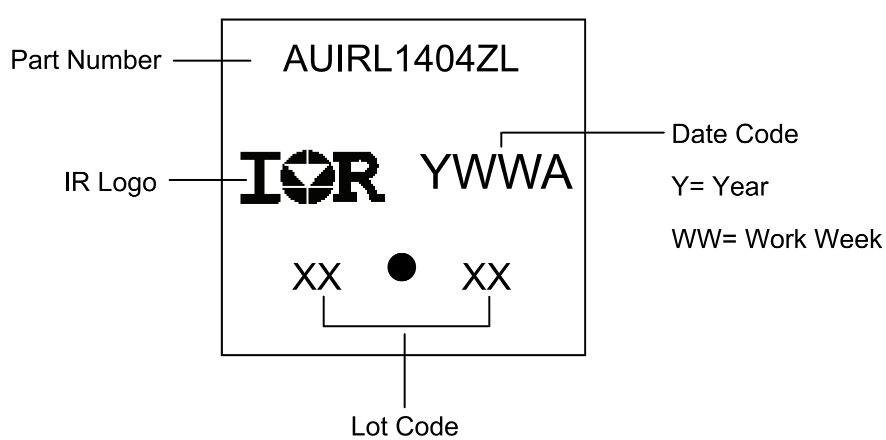
1.- GATE
2.- DRAIN
3.- SOURCE
4.- DRAIN

DIODES

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

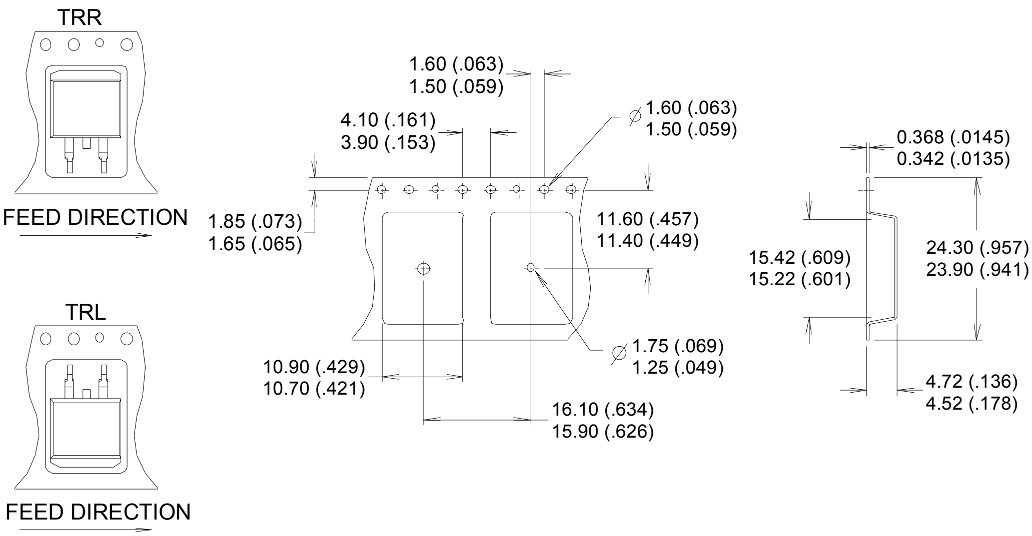
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1	2.03	3.02	.080	.119	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	5
b2	1.14	1.78	.045	.070	
b3	1.14	1.73	.045	.068	5
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	5
c2	1.14	1.65	.045	.065	
D	8.38	9.65	.330	.380	3
D1	6.86	–	.270	–	4
E	9.65	10.67	.380	.420	3,4
E1	6.22	–	.245		4
e	2.54 BSC		.100 BSC		
L	13.46	14.10	.530	.555	
L1	–	1.65	–	.065	4
L2	3.56	3.71	.140	.146	

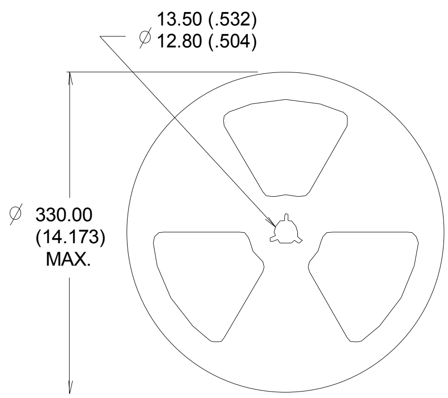
TO-262 Part Marking Information

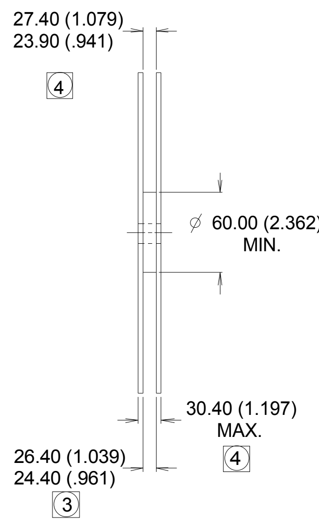


Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

D^2Pak (TO-263AB) 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.

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

Qualification Information

Qualification Level		Automotive (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-220 Pak	N/A
		D^2-Pak	MSL1
		TO-262	
ESD	Machine Model	Class M4 (+/- 425V)† AEC-Q101-002	
	Human Body Model	Class H1C (+/- 2000V)† AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 1125V)† AEC-Q101-005	
RoHS Compliant		Yes	

Revision History

Date	Comments
10/27/2015	• Updated datasheet with corporate template • Corrected ordering table on page 1.

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