

Features

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

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 wide variety of other applications.

Applications

- Electric Power Steering (EPS)
- Battery Switch
- Start/Stop Micro Hybrid
- Heavy Loads
- DC-DC Applications

Ordering Information

Base part number	Package Type	Standard Pack	Quantity	Complete Part Number
AUIRFB8407	TO-220	Tube	50	AUIRFB8407
AUIRFSL8407	TO-262	Tube	50	AUIRFSL8407
AUIRFS8407	D2Pak	Tube	50	AUIRFS8407
AUIRFS8407	D2Pak	Tape and Reel Left	800	AUIRFS8407TRL

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.

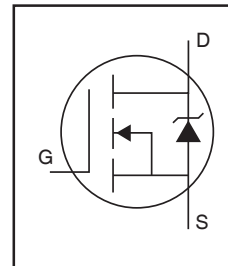
Symbol	Parameter	Max.	Units
I_D @ $T_C = 25^\circ\text{C}$	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)	250①	A
I_D @ $T_C = 100^\circ\text{C}$	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)	180	
I_D @ $T_C = 25^\circ\text{C}$	Continuous Drain Current, V_{GS} @ 10V (Wire Bond Limited)	195	
I_{DM}	Pulsed Drain Current ②	1000②	
P_D @ $T_C = 25^\circ\text{C}$	Maximum Power Dissipation	230	W
	Linear Derating Factor	1.5	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
T_J	Operating Junction and	-55 to + 175	°C
T_{STG}	Storage Temperature Range		
	Soldering Temperature, for 10 seconds (1.6mm from case)	300	
	Mounting torque, 6-32 or M3 screw	10lbf·in (1.1N·m)	

Avalanche Characteristics

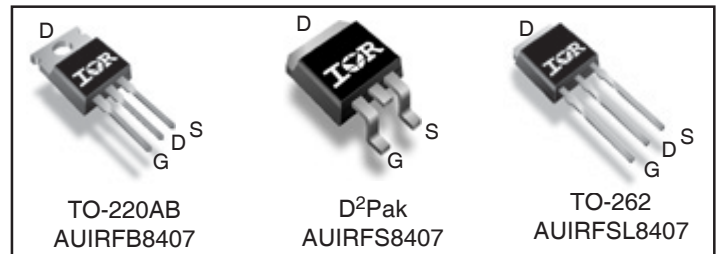
E_{AS} (Thermally limited)	Single Pulse Avalanche Energy ③	350	mJ
E_{AS} (tested)	Single Pulse Avalanche Energy Tested Value ③	500	
I_{AR}	Avalanche Current ②	See Fig. 14, 15, 22a, 22b	A
E_{AR}	Repetitive Avalanche Energy ②		mJ

HEXFET® is a registered trademark of International Rectifier.

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



V_{DS}	40V
$R_{DS(on)}$ typ.	1.4mΩ
(SMD version) max.	1.8mΩ
I_D (Silicon Limited)	250A①
I_D (Package Limited)	195A



G	D	S
Gate	Drain	Source

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

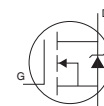
Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	40	—	—	V	$V_{GS} = 0V, I_D = 250\mu A$
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.029	—	V/ $^\circ\text{C}$	Reference to 25°C , $I_D = 1mA$ ②
$R_{DS(on)}$ SMD	Static Drain-to-Source On-Resistance	—	1.4	1.8	m Ω	$V_{GS} = 10V, I_D = 100A$
$R_{DS(on)}$ TO-220		—	1.6	2.0		$V_{GS} = 10V, I_D = 100A$
$V_{GS(th)}$	Gate Threshold Voltage	2.0	3.0	4.0	V	$V_{DS} = V_{GS}, I_D = 150\mu A$
I_{DSS}	Drain-to-Source Leakage Current	—	—	1.0	μA	$V_{DS} = 40V, V_{GS} = 0V$
		—	—	150		$V_{DS} = 40V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
I_{GSS}	Gate-to-Source Forward Leakage	—	—	100	nA	$V_{GS} = 20V$
	Gate-to-Source Reverse Leakage	—	—	-100		$V_{GS} = -20V$
R_G	Internal Gate Resistance	—	2.2	—	Ω	

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
g_{fs}	Forward Transconductance	160	—	—	S	$V_{DS} = 10V, I_D = 100A$
Q_g	Total Gate Charge	—	150	225	nC	$I_D = 100A$
Q_{gs}	Gate-to-Source Charge	—	41	—		$V_{DS} = 20V$
Q_{gd}	Gate-to-Drain ("Miller") Charge	—	51	—		$V_{GS} = 10V$ ⑤
Q_{sync}	Total Gate Charge Sync. ($Q_g - Q_{gd}$)	—	99	—		$I_D = 100A, V_{DS} = 20V, V_{GS} = 10V$
$t_{d(on)}$	Turn-On Delay Time	—	19	—	ns	$V_{DD} = 20V$
t_r	Rise Time	—	70	—		$I_D = 30A$
$t_{d(off)}$	Turn-Off Delay Time	—	78	—		$R_G = 2.7\Omega$
t_f	Fall Time	—	53	—		$V_{GS} = 10V$ ⑤
C_{iss}	Input Capacitance	—	7330	—	pF	$V_{GS} = 0V$
C_{oss}	Output Capacitance	—	1095	—		$V_{DS} = 25V$
C_{rss}	Reverse Transfer Capacitance	—	745	—		$f = 1.0\text{ MHz}$, See Fig. 5
$C_{oss\text{ eff. (ER)}}$	Effective Output Capacitance (Energy Related) ⑦	—	1310	—		$V_{GS} = 0V, V_{DS} = 0V$ to $32V$ ⑦, See Fig. 11
$C_{oss\text{ eff. (TR)}}$	Effective Output Capacitance (Time Related) ⑧	—	1735	—		$V_{GS} = 0V, V_{DS} = 0V$ to $32V$ ⑧

Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	—	—	250	A	MOSFET symbol showing the integral reverse p-n junction diode.
I_{SM}	Pulsed Source Current (Body Diode) ②	—	—	1000	A	
V_{SD}	Diode Forward Voltage	—	1.0	1.3	V	$T_J = 25^\circ\text{C}, I_S = 100A, V_{GS} = 0V$ ⑤
dv/dt	Peak Diode Recovery ④	—	3.0	—	V/ns	$T_J = 175^\circ\text{C}, I_S = 100A, V_{DS} = 40V$ ⑤
t_{rr}	Reverse Recovery Time	—	30	—	ns	$T_J = 25^\circ\text{C}$ $V_R = 34V$,
		—	30	—		$T_J = 125^\circ\text{C}$ $I_F = 100A$
Q_{rr}	Reverse Recovery Charge	—	24	—	nC	$T_J = 25^\circ\text{C}$ $di/dt = 100A/\mu s$ ⑤
		—	25	—		$T_J = 125^\circ\text{C}$
I_{RRM}	Reverse Recovery Current	—	1.3	—	A	$T_J = 25^\circ\text{C}$


Thermal Resistance

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ⑨	—	0.65	$^\circ\text{C/W}$
$R_{\theta CS}$	Case-to-Sink, Flat Greased Surface, TO-220	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient, TO-220 ⑨	—	62	
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount) , D ² Pak ⑧	—	40	

Qualification Information[†]

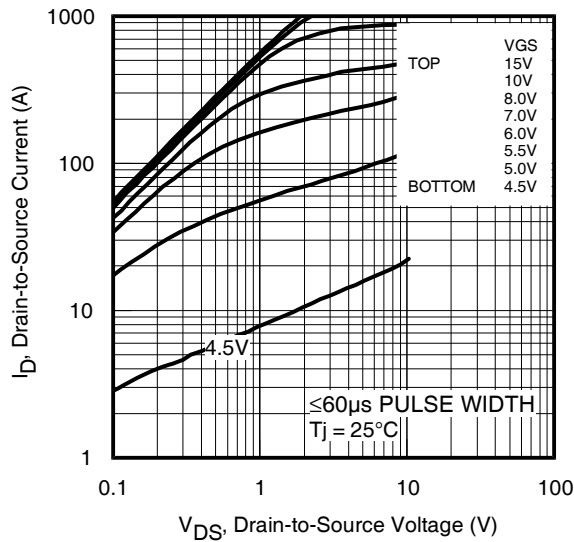
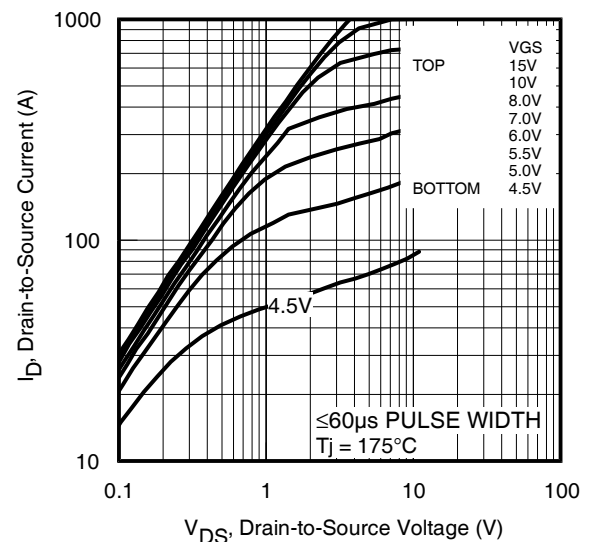
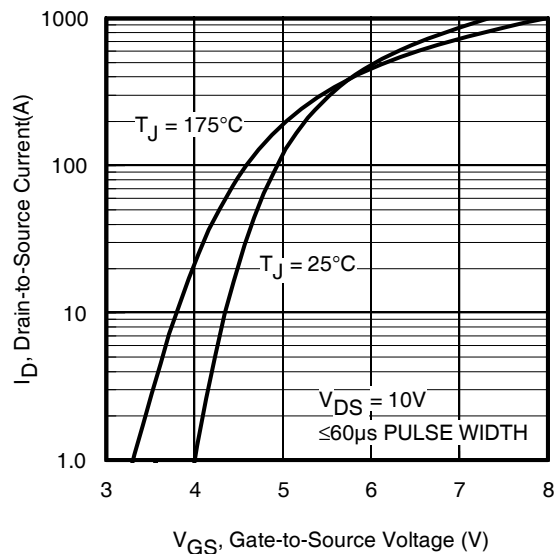
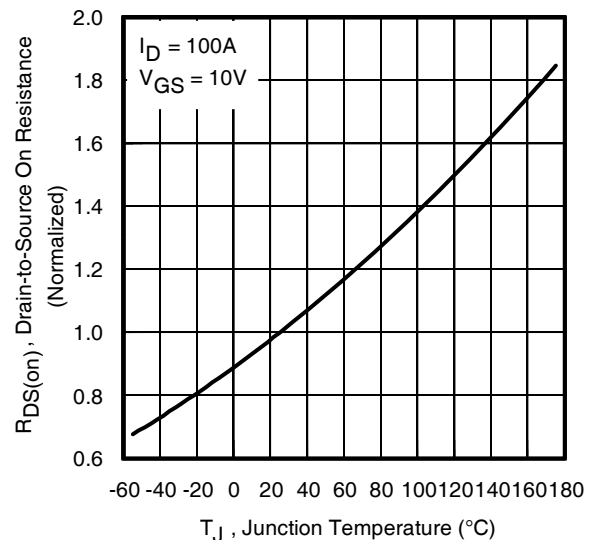
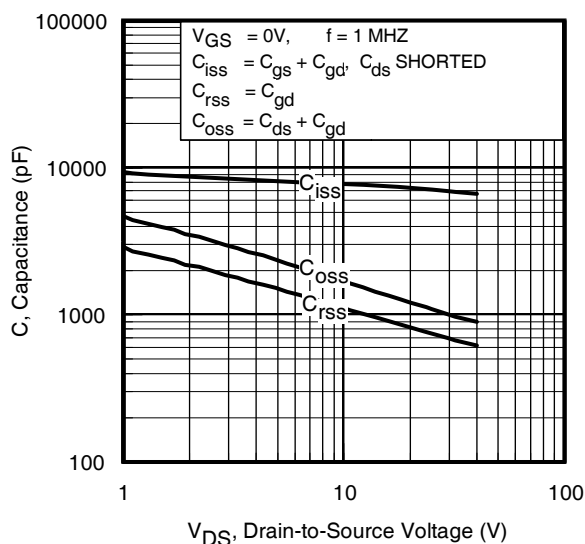
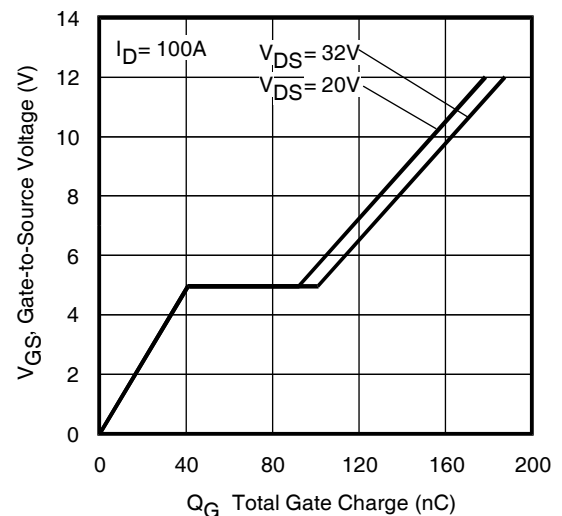
Qualification Level		Automotive (per AEC-Q101)	
		Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
Moisture Sensitivity Level		D2 PAK	MSL1
		TO-262	
		TO-220	N/A
ESD	Machine Model	Class M4 (+/- 800V) ^{††} AEC-Q101-002	
	Human Body Model	Class H2 (+/- 4000V) ^{††} AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 2000V) ^{††} AEC-Q101-005	
RoHS Compliant		Yes	

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

^{††} Highest passing voltage

Notes:

- ① Calculated continuous current based on maximum allowable junction temperature. Bond wire current limit is 195A by source bonding technology. Note that current limitations arising from heating of the device leads may occur with some lead mounting arrangements. (Refer to AN-1140)
- ② Repetitive rating; pulse width limited by max. junction temperature.
- ③ Limited by T_{Jmax} , starting $T_J = 25^\circ\text{C}$, $L = 0.069\text{mH}$
 $R_G = 25\Omega$, $I_{AS} = 100\text{A}$, $V_{GS} = 10\text{V}$.
- ④ $I_{SD} \leq 100\text{A}$, $di/dt \leq 1166\text{A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq 175^\circ\text{C}$.
- ⑤ Pulse width $\leq 400\mu\text{s}$; duty cycle $\leq 2\%$.
- ⑥ C_{OSS} 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} 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 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_θ is measured at T_J approximately 90°C .
- ⑩ Pulse drain current is limited by source bonding technology.


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

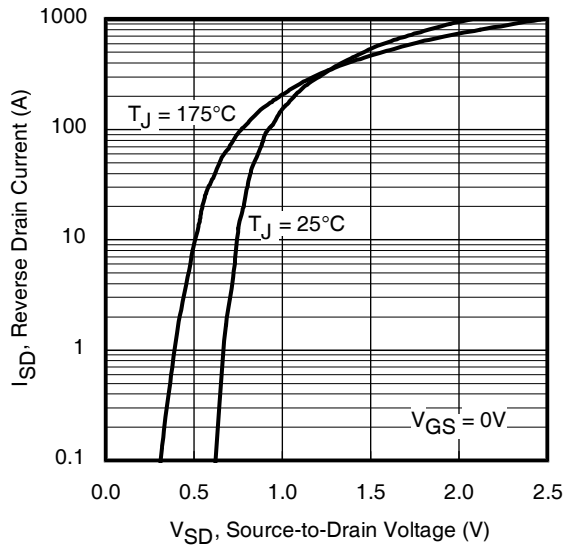


Fig 7. Typical Source-Drain Diode Forward Voltage

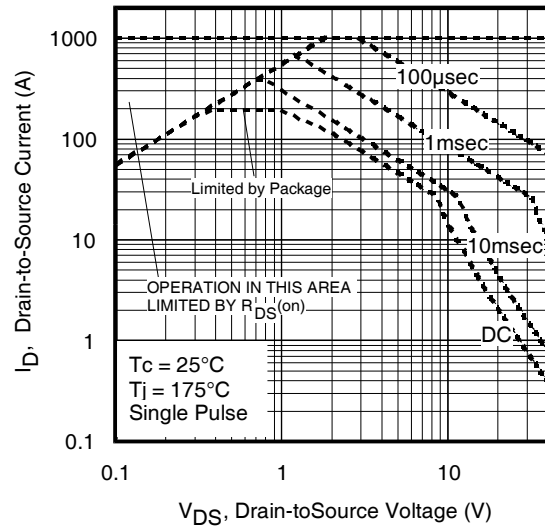


Fig 8. Maximum Safe Operating Area

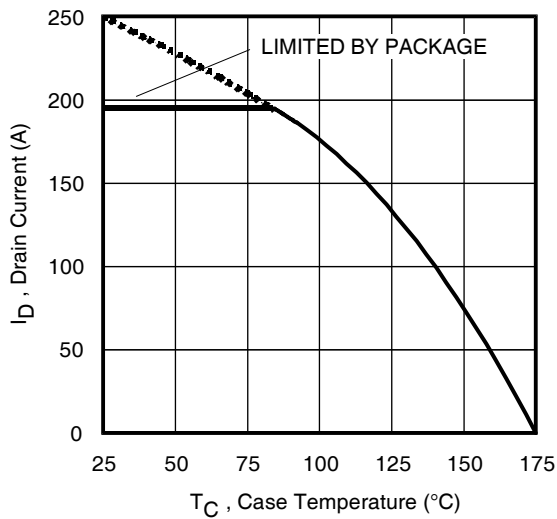


Fig 9. Maximum Drain Current vs. Case Temperature

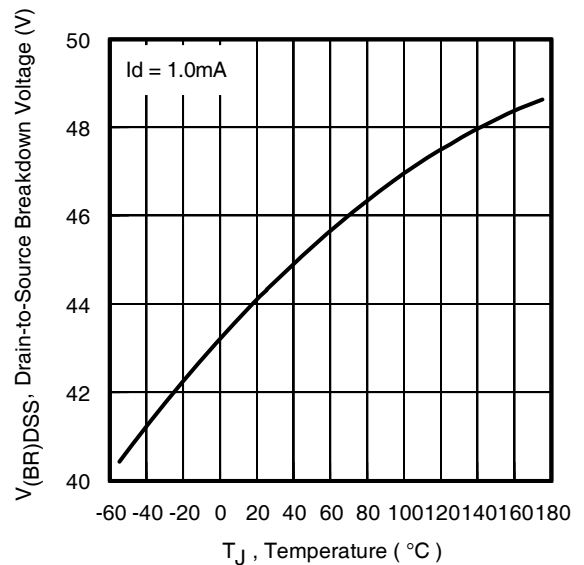


Fig 10. Drain-to-Source Breakdown Voltage

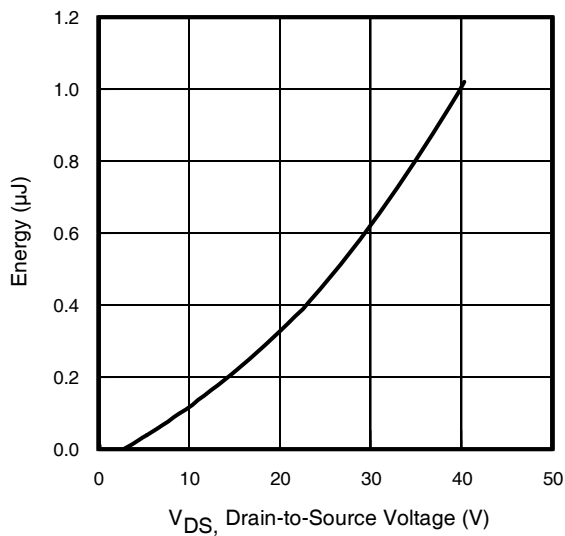


Fig 11. Typical C_{OSS} Stored Energy

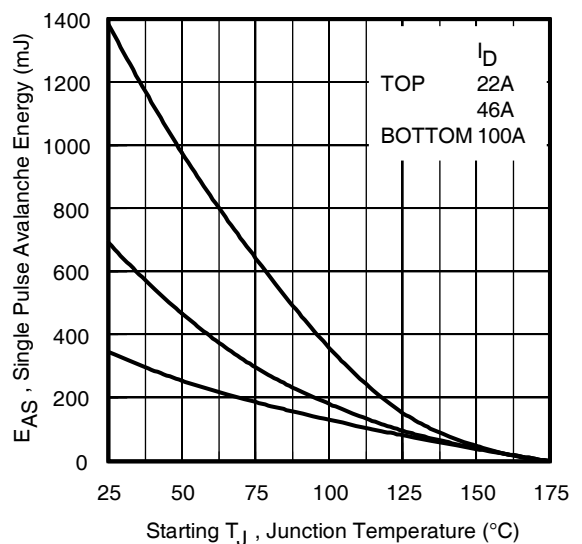


Fig 12. Maximum Avalanche Energy vs. Drain Current

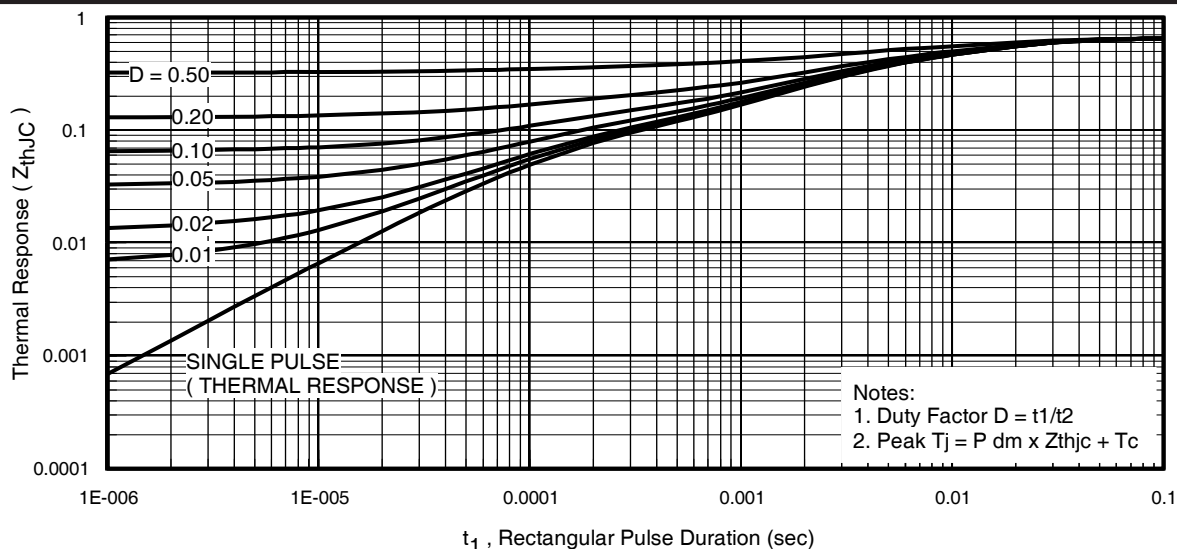


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

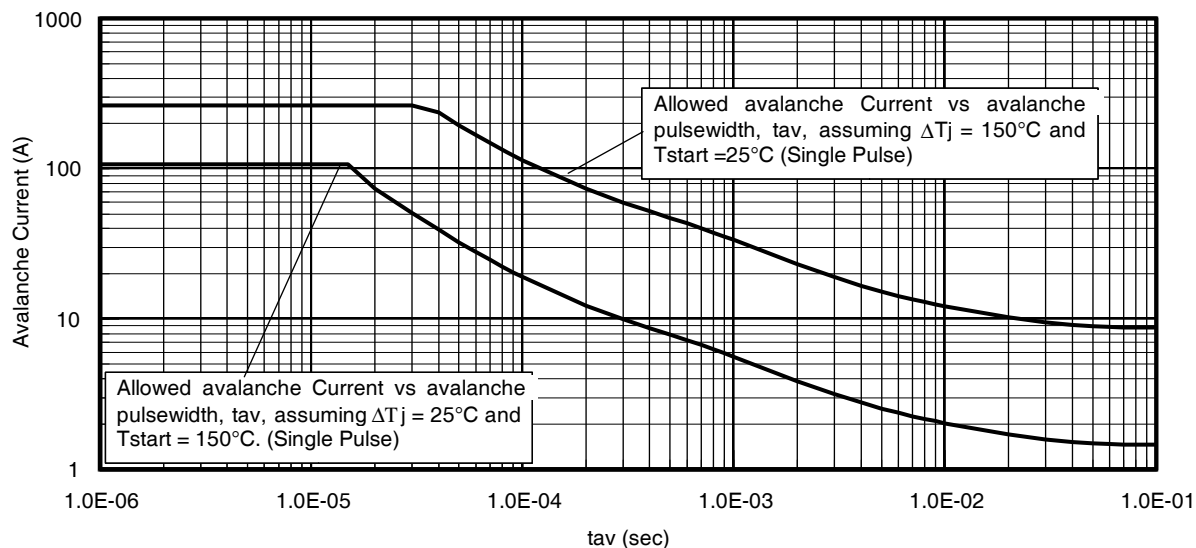
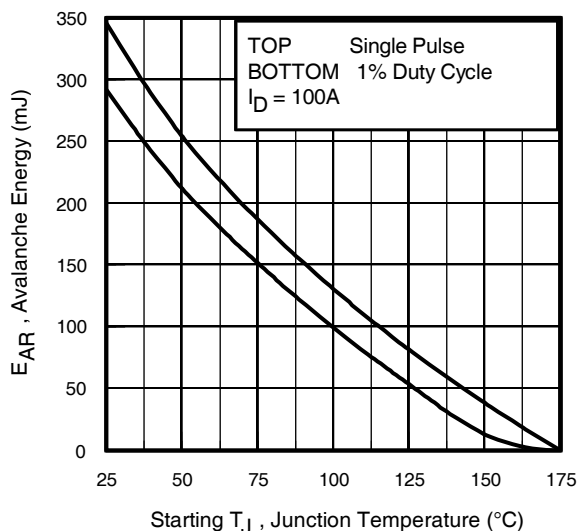


Fig 14. Typical Avalanche Current vs. Pulsewidth



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

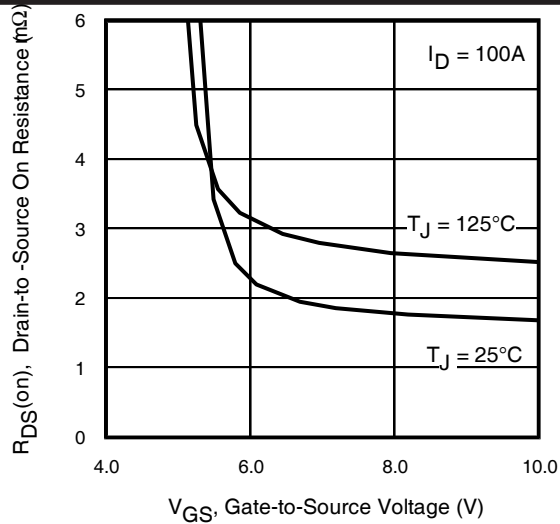
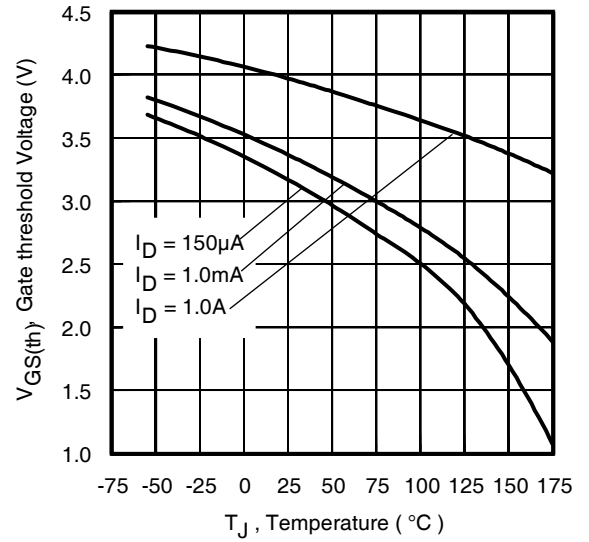
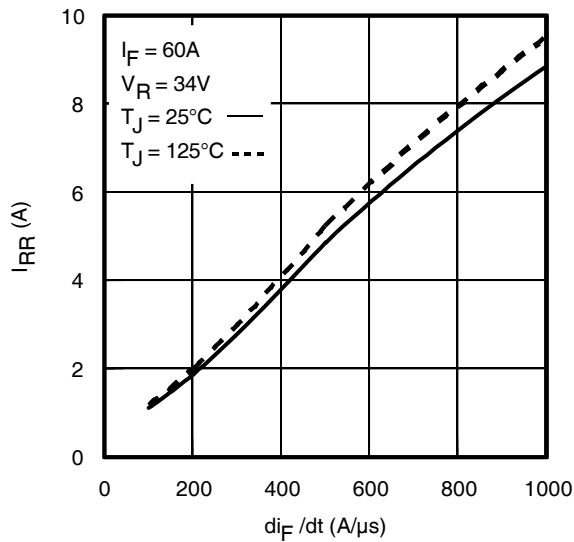
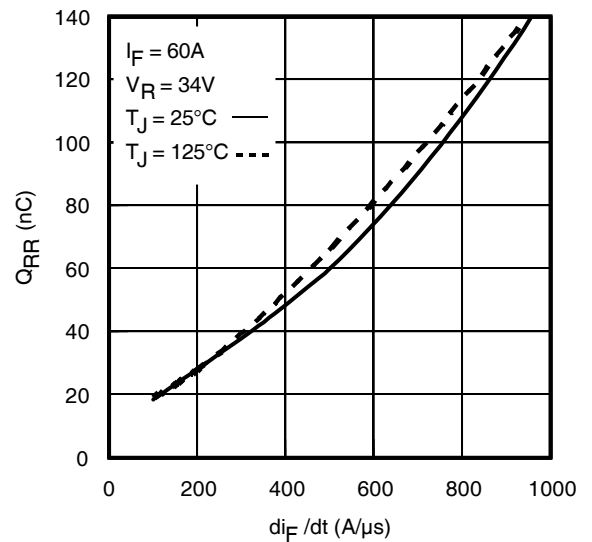
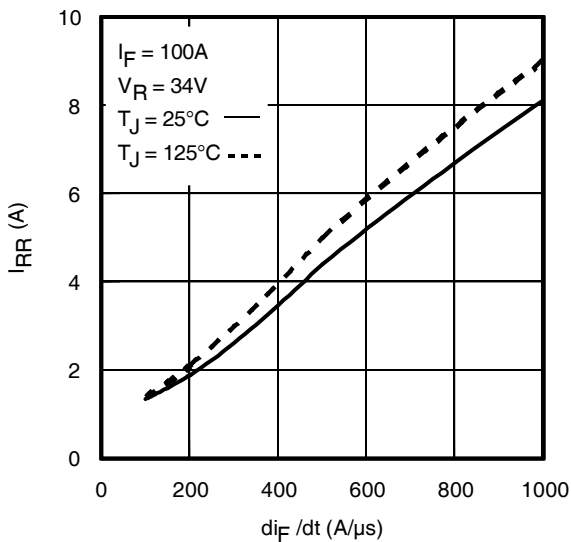
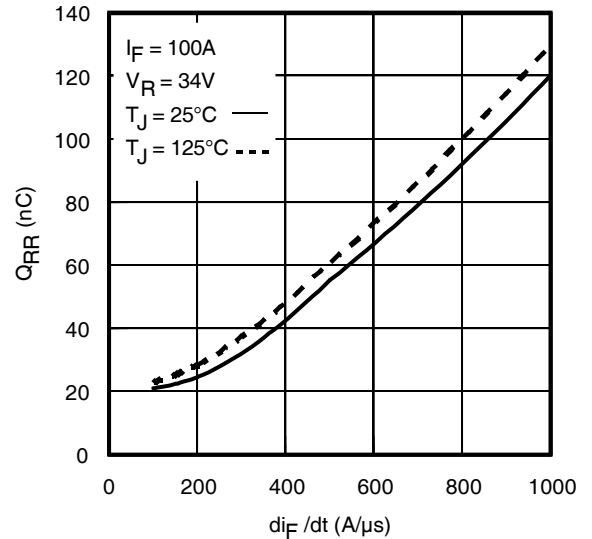
1. Avalanche failures assumption:
Purely a thermal phenomenon and failure occurs at a temperature far in excess of T_{jmax} . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as T_{jmax} is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 24a, 24b.
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 15. Maximum Avalanche Energy vs. Temperature


Fig 16. Typical On-Resistance vs. Gate Voltage

Fig 17. Threshold Voltage vs. Temperature

Fig. 18 - Typical Recovery Current vs. di_T/dt

Fig. 19 - Typical Stored Charge vs. di_T/dt

Fig. 20 - Typical Recovery Current vs. di_T/dt

Fig. 21 - Typical Stored Charge vs. di_T/dt

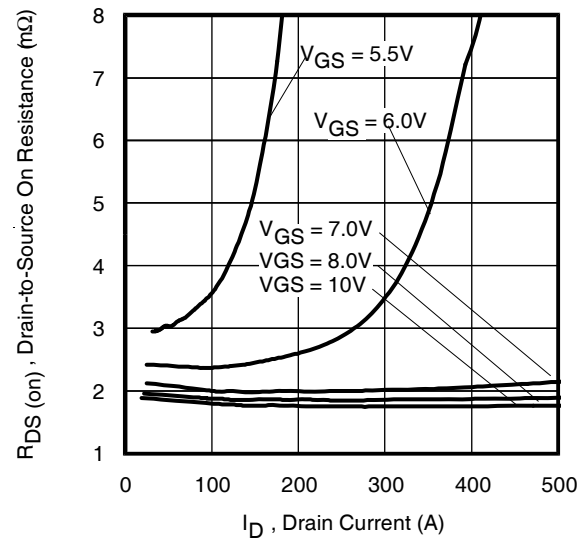
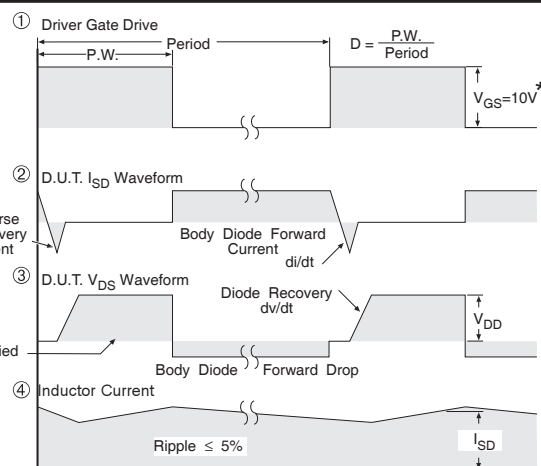
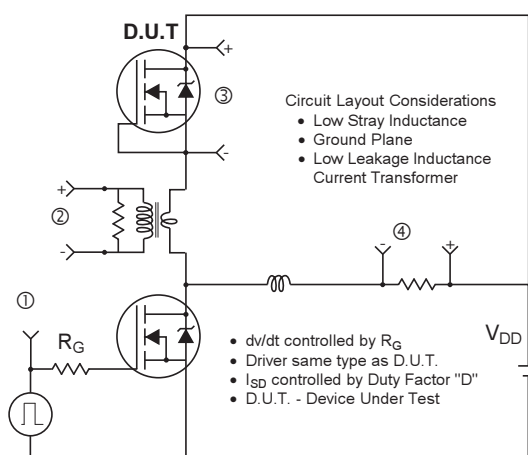


Fig 22. Typical On-Resistance vs. Drain Current



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

Fig 23. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

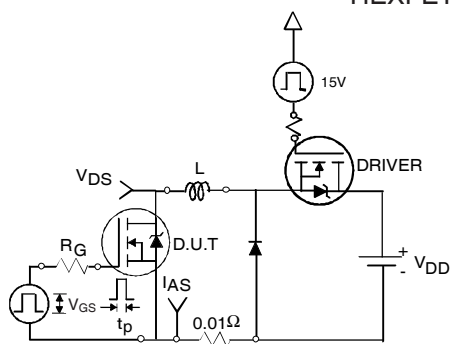


Fig 24a. Unclamped Inductive Test Circuit

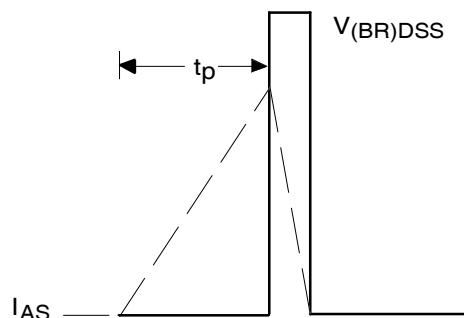


Fig 24b. Unclamped Inductive Waveforms

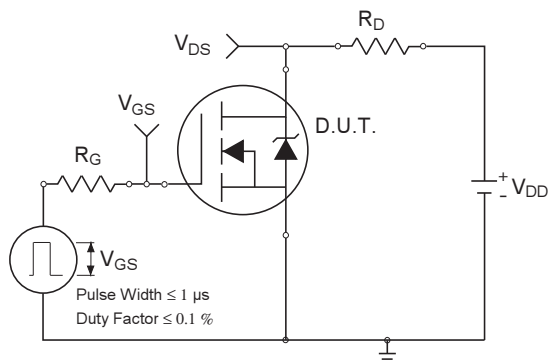


Fig 25a. Switching Time Test Circuit

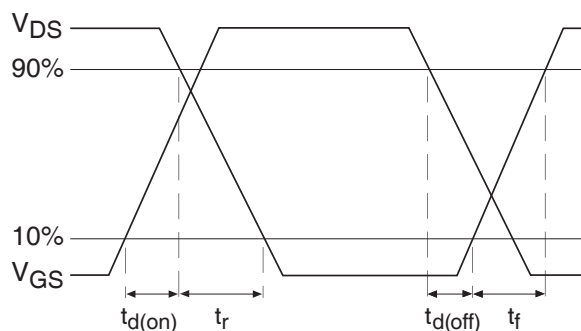


Fig 25b. Switching Time Waveforms

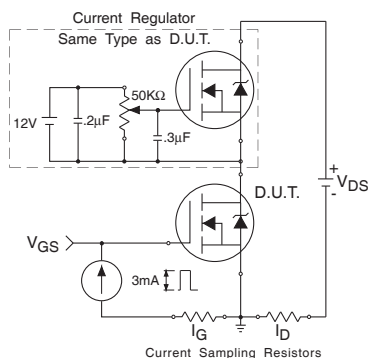


Fig 26a. Gate Charge Test Circuit

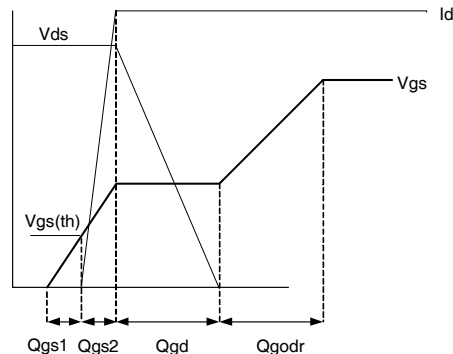
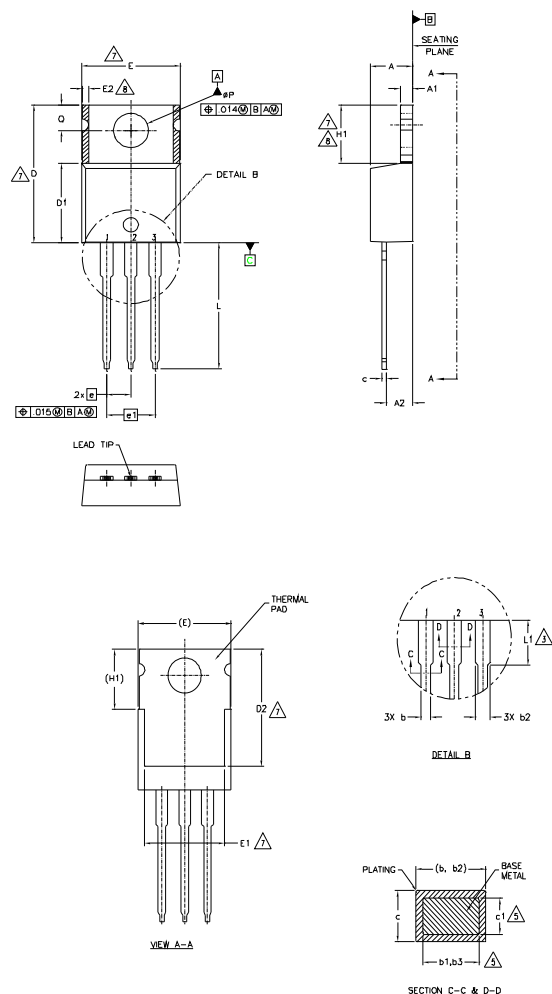


Fig 26b. Gate Charge Waveform

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	5	
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		
b2	1.14	1.78	.045	.070	5	
b3	1.14	1.73	.045	.068		
c	0.36	0.61	.014	.024		
c1	0.36	0.56	.014	.022		
D	14.22	16.51	.560	.650		4
D1	8.38	9.02	.330	.355	7	
D2	11.68	12.88	.460	.507		
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		7,8	
e1	5.08 BSC		.200 BSC			
H1	5.84	6.86	.230	.270		
L	12.70	14.73	.500	.580		
L1	3.56	4.06	.140	.160		3
øP	3.54	4.08	.139	.161		
Q	2.54	3.42	.100	.135		

LEAD ASSIGNMENTS

HEXFET

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

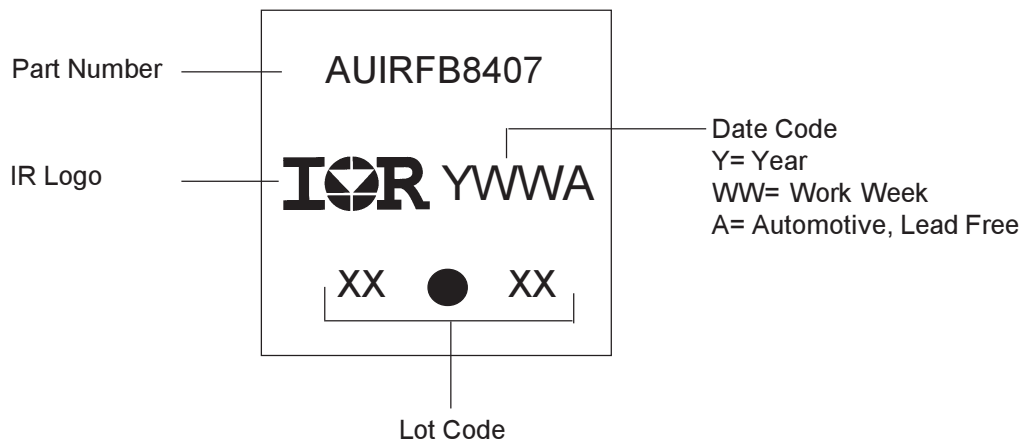
IGBTs, CoPACK

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

DIODES

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

TO-220AB Part Marking Information

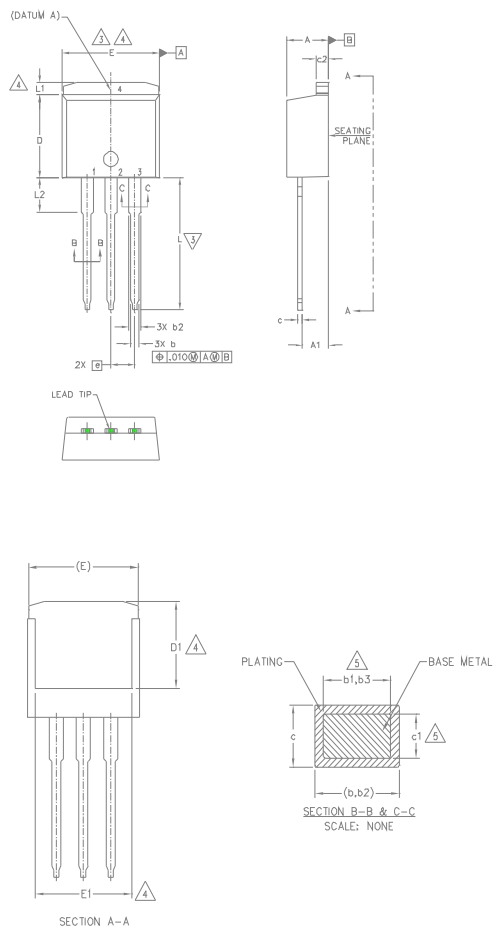


TO-220AB packages are not recommended for Surface Mount Application.

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

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

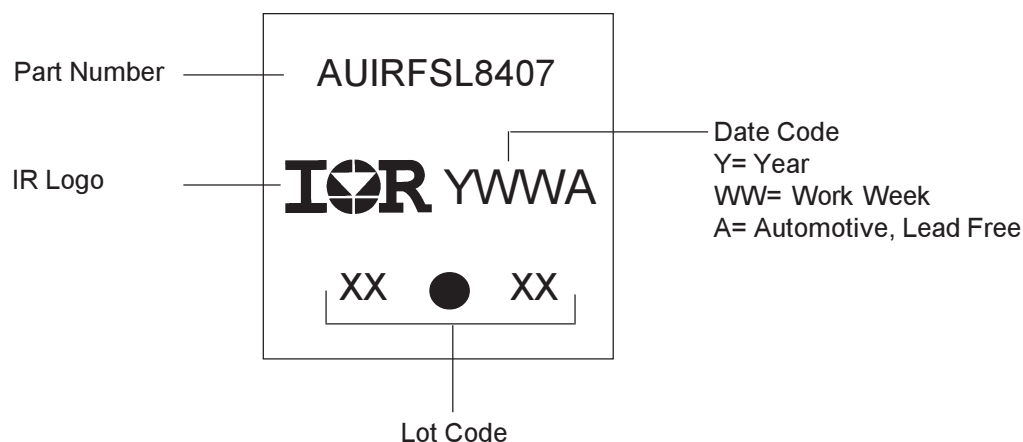
- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

DIODES

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

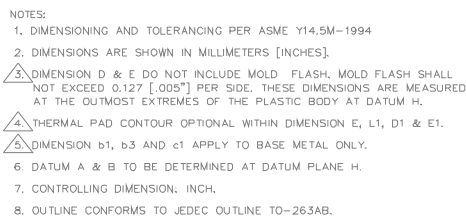
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1	2.03	3.02	.080	.119	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	5
b2	1.14	1.78	.045	.070	5
b3	1.14	1.73	.045	.068	
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	5
c2	1.14	1.65	.045	.065	3
D	8.38	9.65	.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	4
L	13.46	14.10	.530	.555	
L1	—	1.65	—	.065	
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/>

Dimensions are shown in millimeters (inches)



DIODES

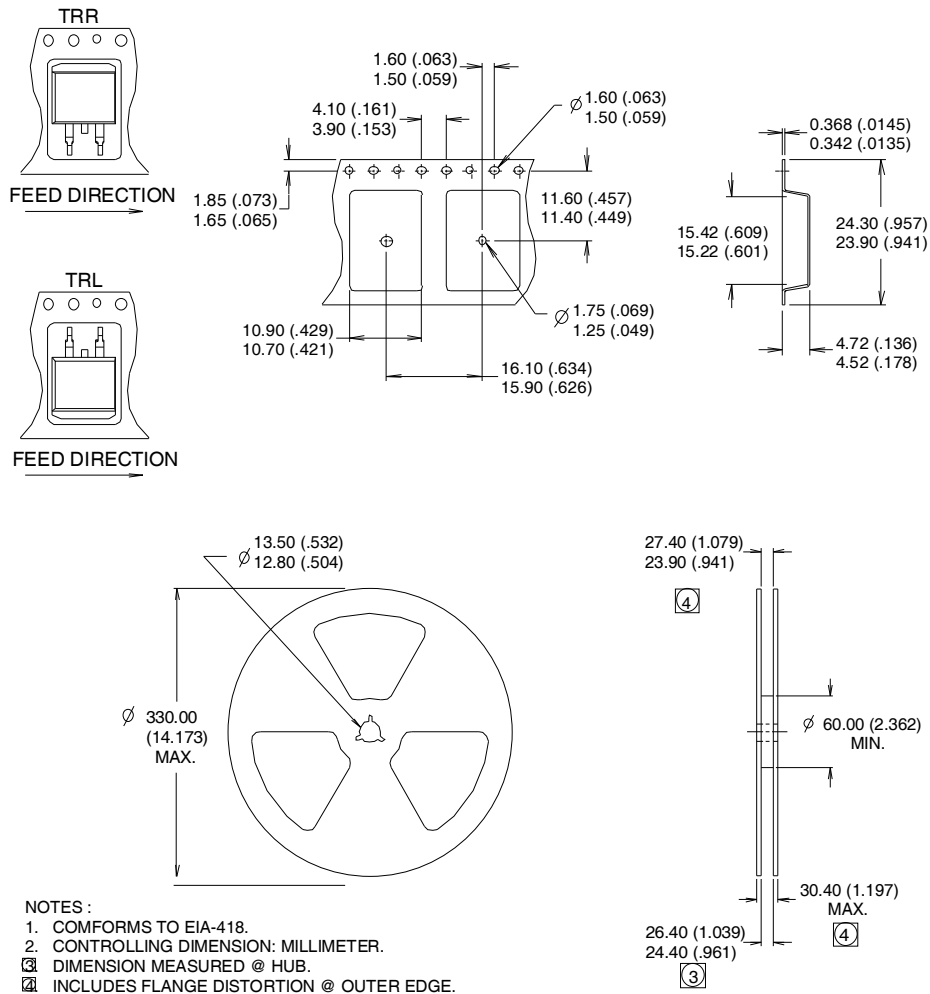
- | | |
|--------------------------------------|----------------------|
| 1.- ANODE (TWO DIE) / OPEN (ONE DIE) | |
| 2. 4.- CATHODE | |
| 3.- ANODE | |
| <u>HXFET</u> | <u>IGBTs, CoPACK</u> |
| 1.- GATE | 1.- GATE |
| 2. 4.- DRAIN | 2. 4.- COLLECTOR |
| 3.- SOURCE | 3.- EMITTER |

D²Pak (TO-263AB) Part Marking Information



D²Pak (TO-263AB) Tape & Reel Information

Dimensions are shown in millimeters (inches)



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

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Revision History

Date	Comment
4/1/2014	• Updated package outline on page 10,11 & 12. • Updated typo on the fig.19 and fig.21, unit of y-axis from "A" to "nC" on page7.