

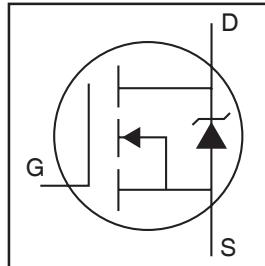
**AUTOMOTIVE GRADE**

**AUIRFB4410**

HEXFET® Power MOSFET

**Features**

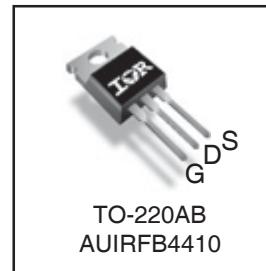
- Advanced Process Technology
- Ultra Low On-Resistance
- Dynamic dV/dT Rating
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to  $T_{jmax}$
- Lead-Free, RoHS Compliant
- Automotive Qualified \*



<b><math>V_{DSS}</math></b>	<b>100V</b>
<b><math>R_{DS(on)}</math></b>	<b>typ. 8.0mΩ</b>
	<b>max. 10mΩ</b>
<b><math>I_D</math> (Silicon Limited)</b>	<b>88A</b>
<b><math>I_D</math> (Package Limited)</b>	<b>75A</b>

**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.



<b>G</b>	<b>D</b>	<b>S</b>
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.

<b>Symbol</b>	<b>Parameter</b>	<b>Max.</b>	<b>Units</b>
$I_D$ @ $T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$ (Silicon Limited)	88①	A
$I_D$ @ $T_C = 100^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$	63	
$I_D$ @ $T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$ (Package Limited)	75	
$I_{DM}$	Pulsed Drain Current ②	380	
$P_D @ T_C = 25^\circ\text{C}$	Maximum Power Dissipation	200	W
	Linear Derating Factor	1.3	W/ $^\circ\text{C}$
$V_{GS}$	Gate-to-Source Voltage	$\pm 20$	V
$dv/dt$	Peak Diode Recovery ④	19	V/ns
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to + 175	$^\circ\text{C}$
	Soldering Temperature, for 10 seconds (1.6mm from case)	300	
	Mounting torque, 6-32 or M3 screw	10lb-in (1.1N·m)	

**Avalanche Characteristics**

$E_{AS}$ (Thermally limited)	Single Pulse Avalanche Energy ③	220	mJ
$I_{AR}$	Avalanche Current ①	See Fig. 14, 15, 16a, 16b	A
$E_{AR}$	Repetitive Avalanche Energy ⑤		mJ

**Thermal Resistance**

<b>Symbol</b>	<b>Parameter</b>	<b>Typ.</b>	<b>Max.</b>	<b>Units</b>
$R_{\theta JC}$	Junction-to-Case ⑧	—	0.61	$^\circ\text{C/W}$
$R_{\theta CS}$	Case-to-Sink, Flat Greased Surface	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient	—	62	

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)

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(\text{BR})\text{DSS}}$	Drain-to-Source Breakdown Voltage	100	—	—	V	$V_{GS} = 0\text{V}$ , $I_D = 250\mu\text{A}$
$\Delta V_{(\text{BR})\text{DSS}}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.094	—	V/ $^\circ\text{C}$	Reference to $25^\circ\text{C}$ , $I_D = 1\text{mA}$ <sup>②</sup>
$R_{\text{DS}(\text{on})}$	Static Drain-to-Source On-Resistance	—	8.0	10	$\text{m}\Omega$	$V_{GS} = 10\text{V}$ , $I_D = 58\text{A}$ <sup>⑤</sup>
$V_{GS(\text{th})}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{DS} = V_{GS}$ , $I_D = 150\mu\text{A}$
$g_{\text{fs}}$	Forward Transconductance	120	—	—	S	$V_{DS} = 50\text{V}$ , $I_D = 58\text{A}$
$R_G$	Gate Input Resistance	—	1.5	—	$\Omega$	$f = 1\text{MHz}$ , open drain
$I_{\text{DSS}}$	Drain-to-Source Leakage Current	—	—	20	$\mu\text{A}$	$V_{DS} = 100\text{V}$ , $V_{GS} = 0\text{V}$
		—	—	250		$V_{DS} = 100\text{V}$ , $V_{GS} = 0\text{V}$ , $T_J = 125^\circ\text{C}$
$I_{\text{GSS}}$	Gate-to-Source Forward Leakage	—	—	200	nA	$V_{GS} = 20\text{V}$
	Gate-to-Source Reverse Leakage	—	—	-200		$V_{GS} = -20\text{V}$

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge	—	120	180	nC	$I_D = 58\text{A}$
$Q_{gs}$	Gate-to-Source Charge	—	31	—		$V_{DS} = 80\text{V}$
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	—	44	—		$V_{GS} = 10\text{V}$ <sup>⑤</sup>
$t_{d(\text{on})}$	Turn-On Delay Time	—	24	—	ns	$V_{DD} = 65\text{V}$
$t_r$	Rise Time	—	80	—		$I_D = 58\text{A}$
$t_{d(\text{off})}$	Turn-Off Delay Time	—	55	—		$R_G = 4.1\Omega$
$t_f$	Fall Time	—	50	—		$V_{GS} = 10\text{V}$ <sup>⑤</sup>
$C_{iss}$	Input Capacitance	—	5150	—	pF	$V_{GS} = 0\text{V}$
$C_{oss}$	Output Capacitance	—	360	—		$V_{DS} = 50\text{V}$
$C_{rss}$	Reverse Transfer Capacitance	—	190	—		$f = 1.0\text{MHz}$
$C_{oss \text{ eff. (ER)}}$	Effective Output Capacitance (Energy Related)	—	420	—		$V_{GS} = 0\text{V}$ , $V_{DS} = 0\text{V}$ to $80\text{V}$ <sup>⑦</sup> , See Fig.11
$C_{oss \text{ eff. (TR)}}$	Effective Output Capacitance (Time Related) <sup>⑥</sup>	—	500	—		$V_{GS} = 0\text{V}$ , $V_{DS} = 0\text{V}$ to $80\text{V}$ <sup>⑥</sup> , See Fig. 5

## Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_s$	Continuous Source Current (Body Diode)	—	—	88 <sup>①</sup>	A	MOSFET symbol showing the integral reverse p-n junction diode.
$I_{\text{SM}}$	Pulsed Source Current (Body Diode) <sup>②</sup>	—	—	380	A	
$V_{SD}$	Diode Forward Voltage	—	—	1.3	V	$T_J = 25^\circ\text{C}$ , $I_s = 58\text{A}$ , $V_{GS} = 0\text{V}$ <sup>⑤</sup>
$t_{rr}$	Reverse Recovery Time	—	38	56	ns	$T_J = 25^\circ\text{C}$ $V_R = 85\text{V}$ ,
		—	51	77		$T_J = 125^\circ\text{C}$ $I_F = 58\text{A}$
$Q_{rr}$	Reverse Recovery Charge	—	61	92		$T_J = 25^\circ\text{C}$ $di/dt = 100\text{A}/\mu\text{s}$ <sup>⑤</sup>
		—	110	170		$T_J = 125^\circ\text{C}$
$I_{RRM}$	Reverse Recovery Current	—	2.8	—	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:

- <sup>①</sup> Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 75A.  
<sup>②</sup> Repetitive rating; pulse width limited by max. junction temperature.  
<sup>③</sup> Limited by  $T_{J\text{max}}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.14\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 58\text{A}$ ,  $V_{GS} = 10\text{V}$ . Part not recommended for use above this value.  
<sup>④</sup>  $I_{SD} \leq 58\text{A}$ ,  $di/dt \leq 650\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(\text{BR})\text{DSS}}$ ,  $T_J \leq 175^\circ\text{C}$ .  
<sup>⑤</sup> Pulse width  $\leq 400\mu\text{s}$ ; duty cycle  $\leq 2\%$ .  
<sup>⑥</sup>  $C_{oss \text{ eff. (TR)}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .  
<sup>⑦</sup>  $C_{oss \text{ eff. (ER)}}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .  
<sup>⑨</sup>  $R_\theta$  is measured at  $T_J$  approximately  $90^\circ\text{C}$ .

**Qualification Information<sup>†</sup>**

<b>Qualification Level</b>		Automotive (per AEC-Q101) <sup>††</sup>	
		Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
<b>Moisture Sensitivity Level</b>		TO-220AB	N/A
<b>ESD</b>	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	
<b>RoHS Compliant</b>		Yes	

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

<sup>††</sup> Exceptions to AEC-Q101 requirements are noted in the qualification report.

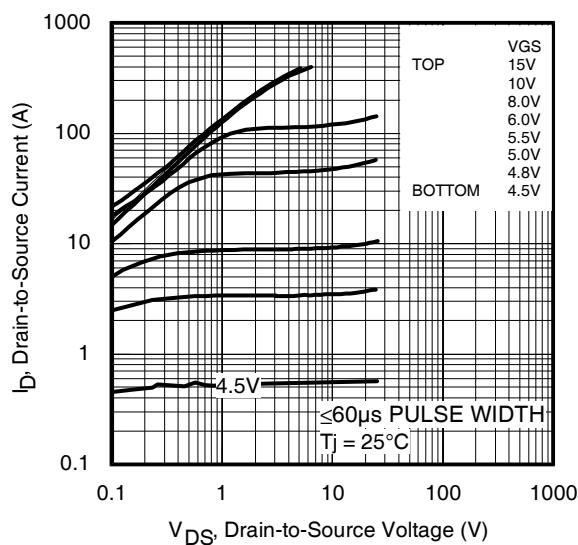


Fig 1. Typical Output Characteristics

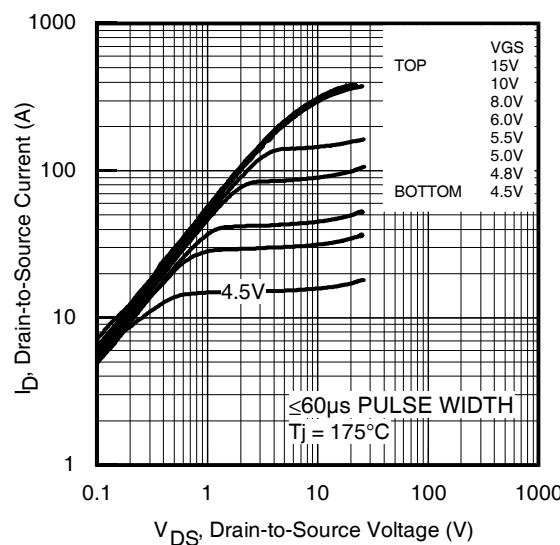


Fig 2. Typical Output Characteristics

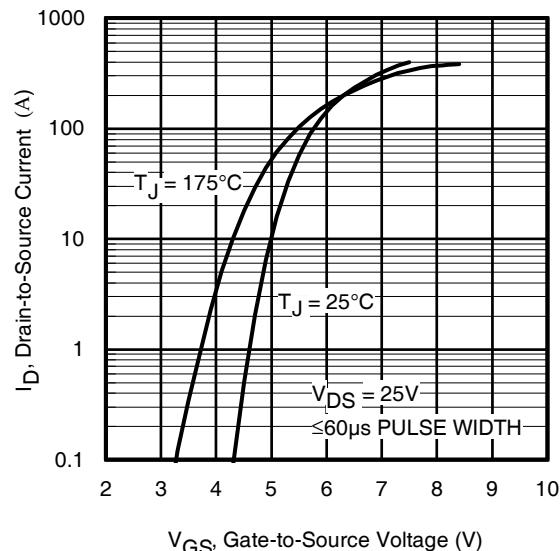


Fig 3. Typical Transfer Characteristics

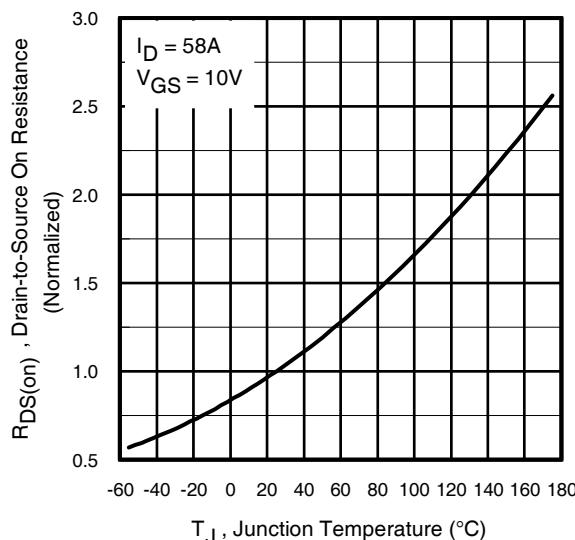


Fig 4. Normalized On-Resistance vs. Temperature

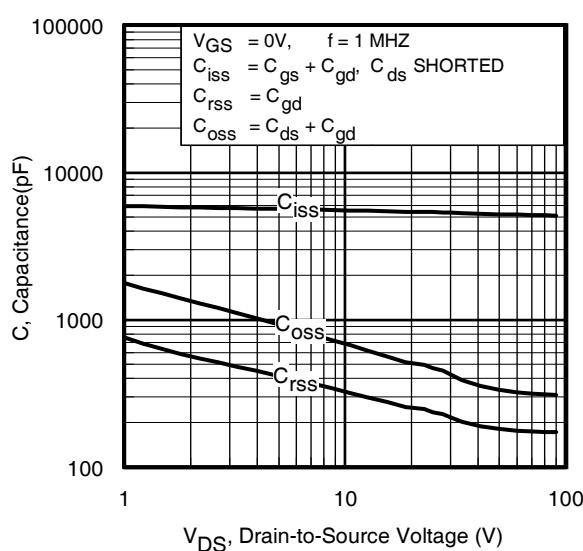


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

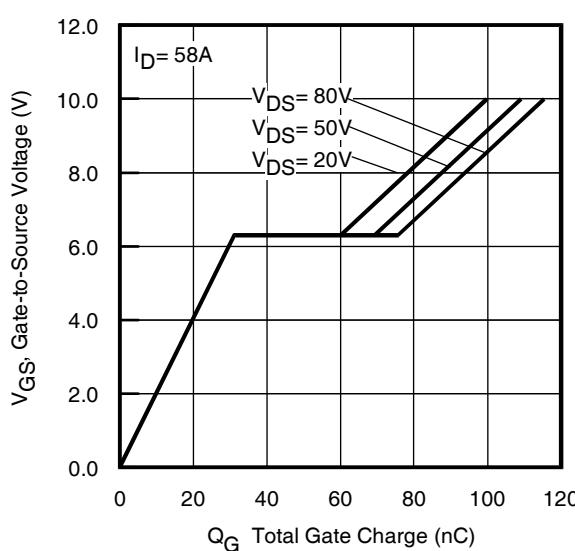


Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage

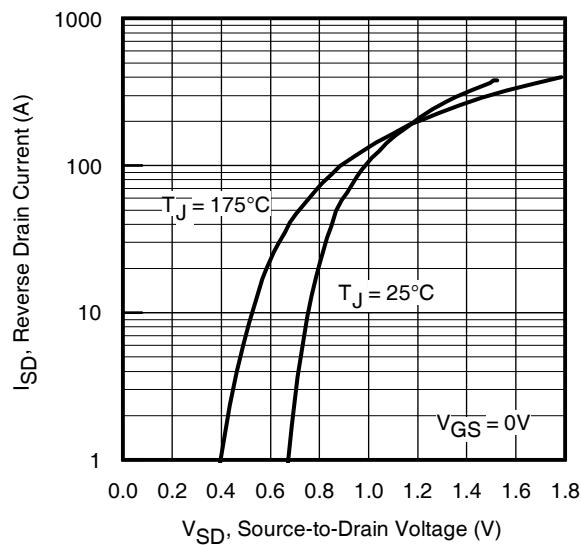


Fig 7. Typical Source-Drain Diode Forward Voltage

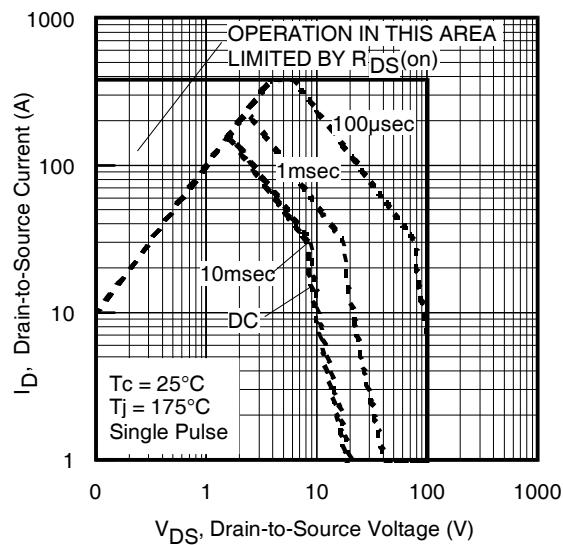


Fig 8. Maximum Safe Operating Area

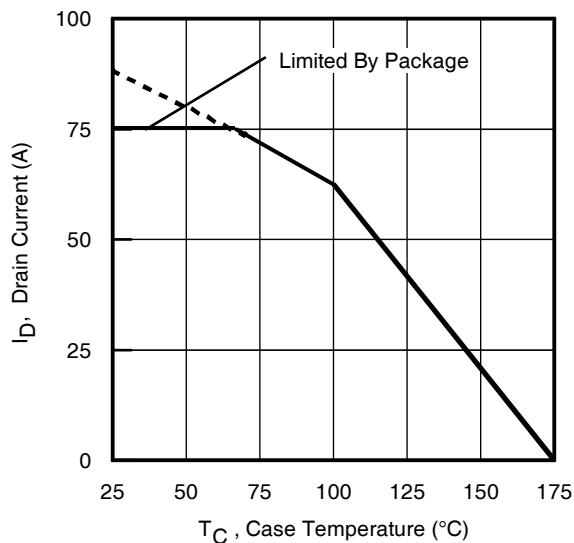


Fig 9. Maximum Drain Current vs. Case Temperature

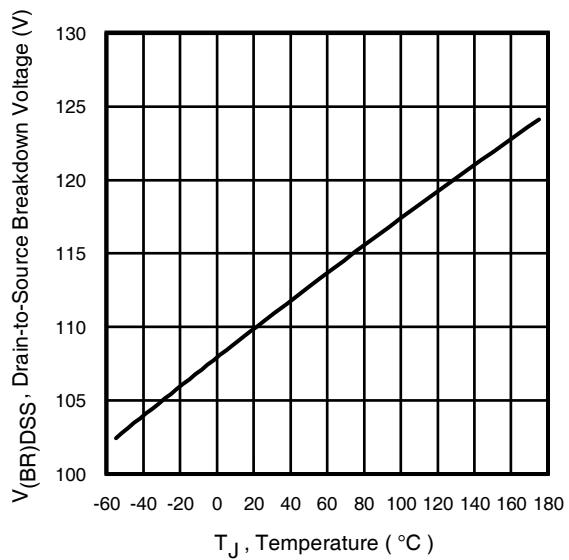


Fig 10. Drain-to-Source Breakdown Voltage

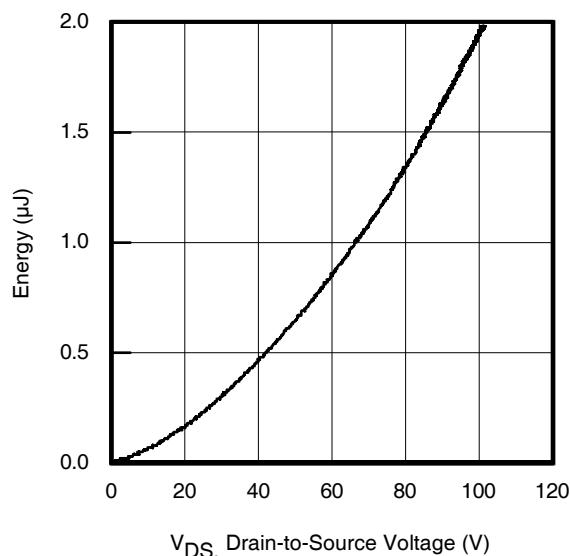


Fig 11. Typical  $C_{oss}$  Stored Energy

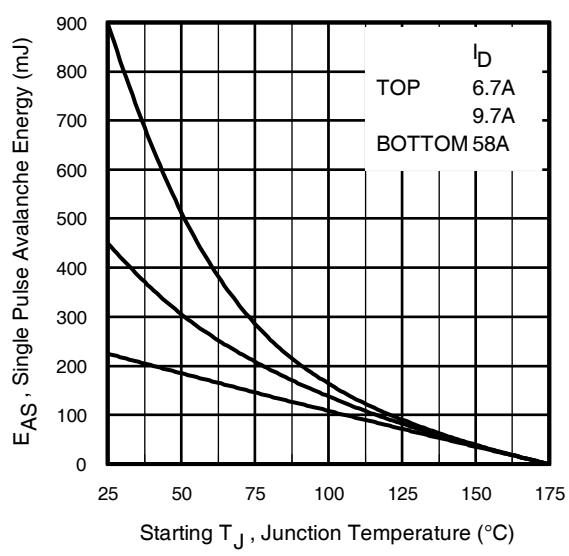


Fig 12. Maximum Avalanche Energy vs. Drain Current

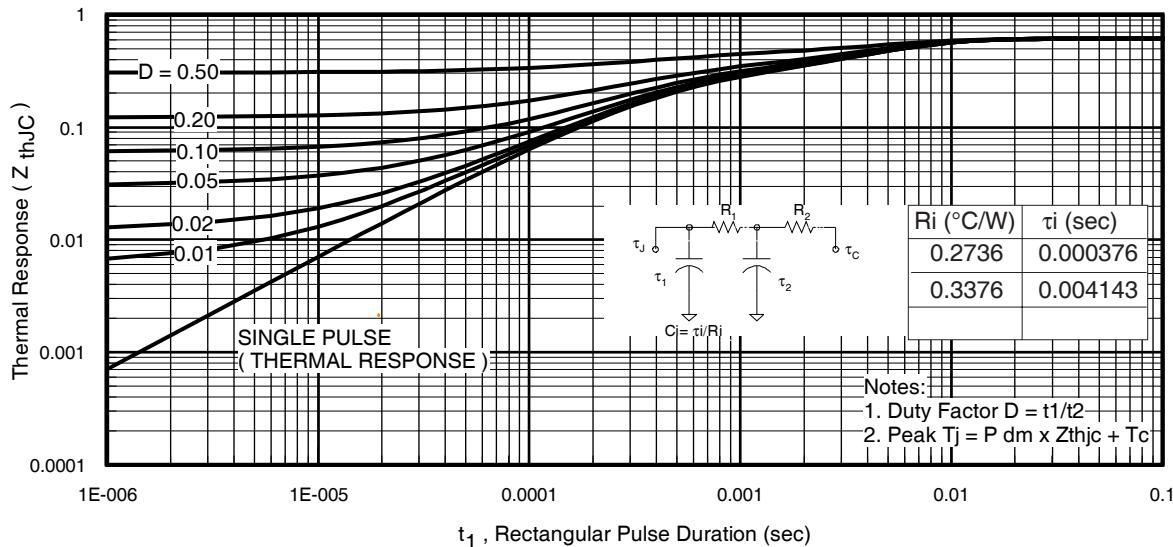


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

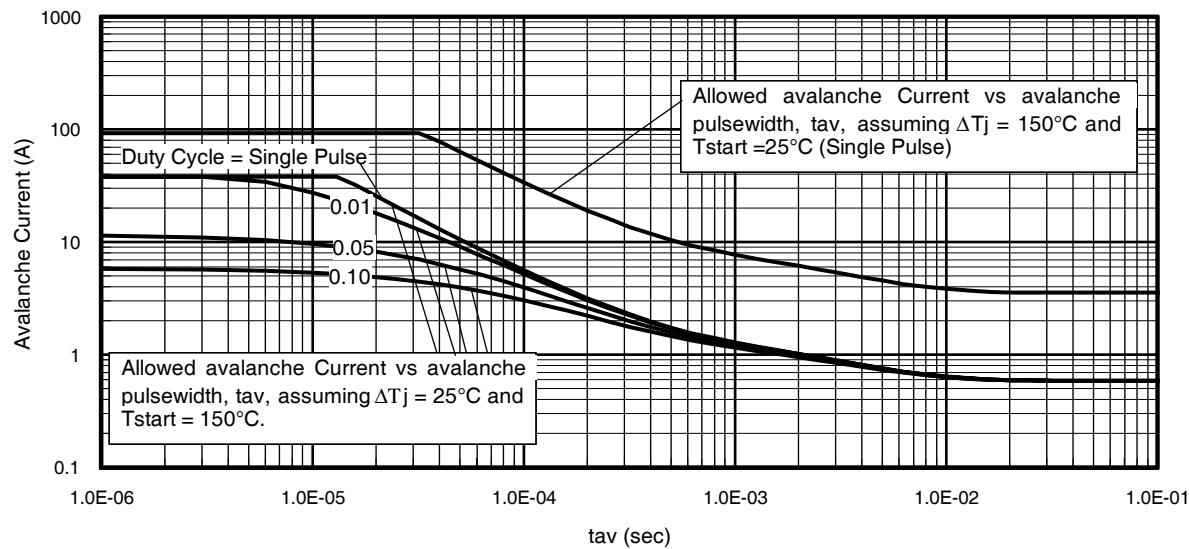


Fig 14. Typical Avalanche Current vs. Pulsewidth

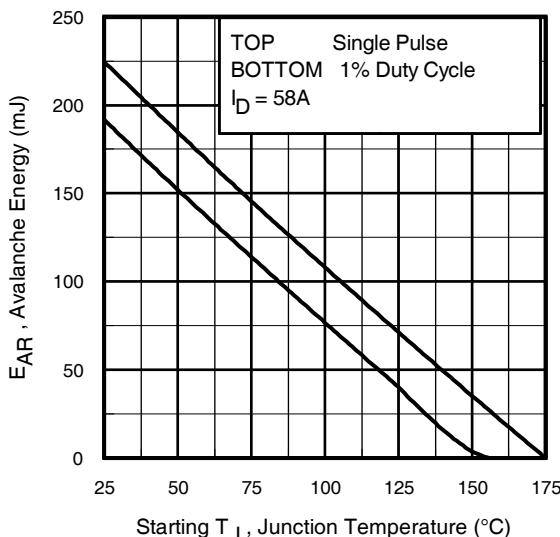


Fig 15. Maximum Avalanche Energy vs. Temperature

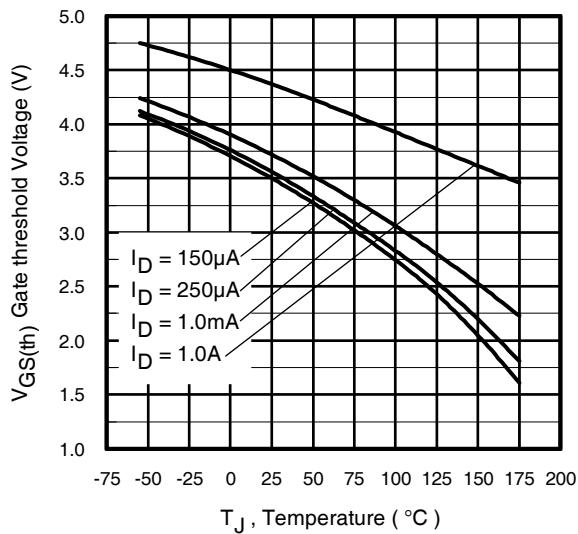
Notes on Repetitive Avalanche Curves , Figures 14, 15:  
(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

1. Avalanche failures assumption:  
Purely a thermal phenomenon and failure occurs at a temperature far in excess of  $T_{j\max}$ . This is validated for every part type.
  2. Safe operation in Avalanche is allowed as long as neither  $T_{j\max}$  nor  $I_{av\ (max)}$  is exceeded.
  3. Equation below based on circuit and waveforms shown in Figures 16a, 16b.
  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  $T_{j\max}$  (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)

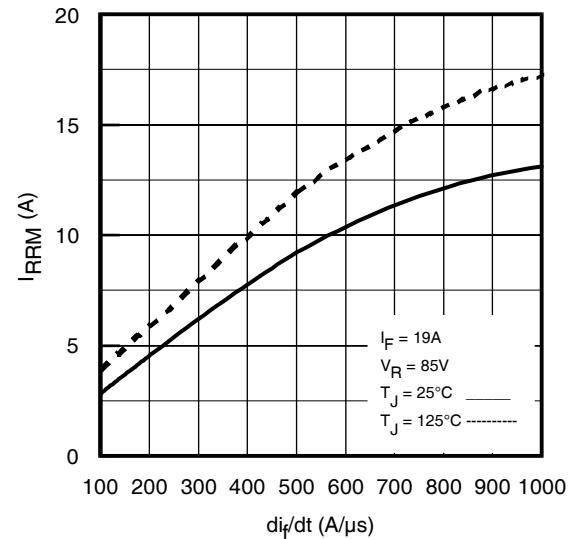
$$P_D\ (ave) = 1/2 (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$

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

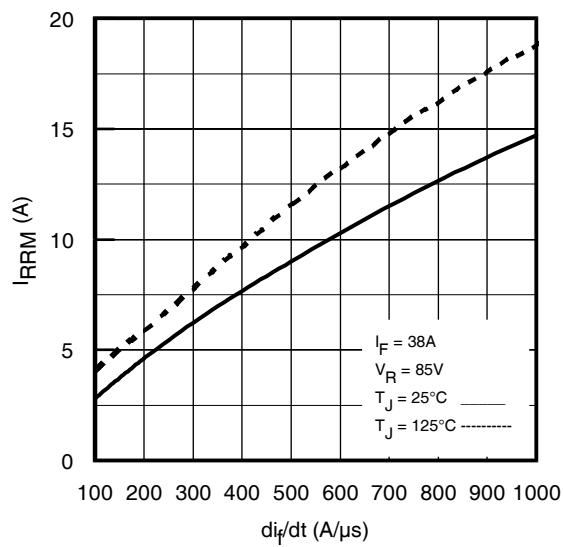
$$E_{AS\ (AR)} = P_D\ (ave) \cdot t_{av}$$



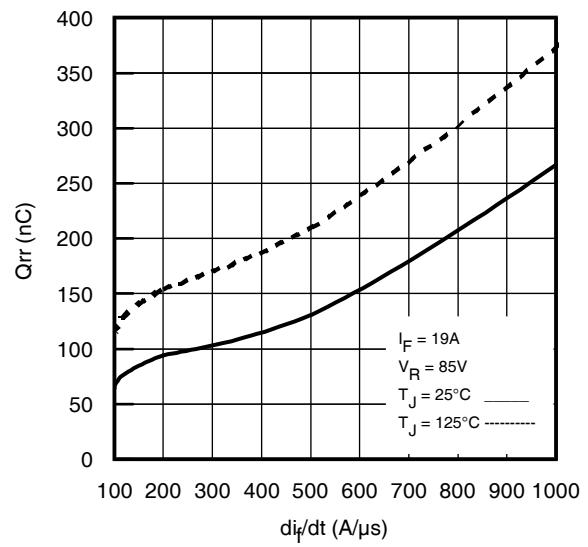
**Fig. 16.** Threshold Voltage vs. Temperature



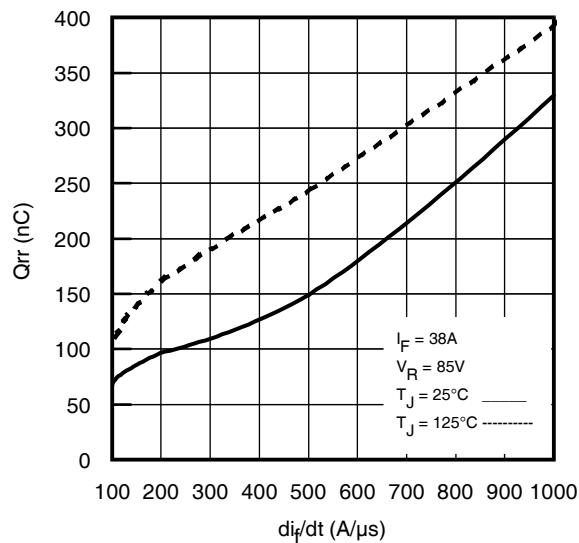
**Fig. 17 -** Typical Recovery Current vs.  $di_f/dt$



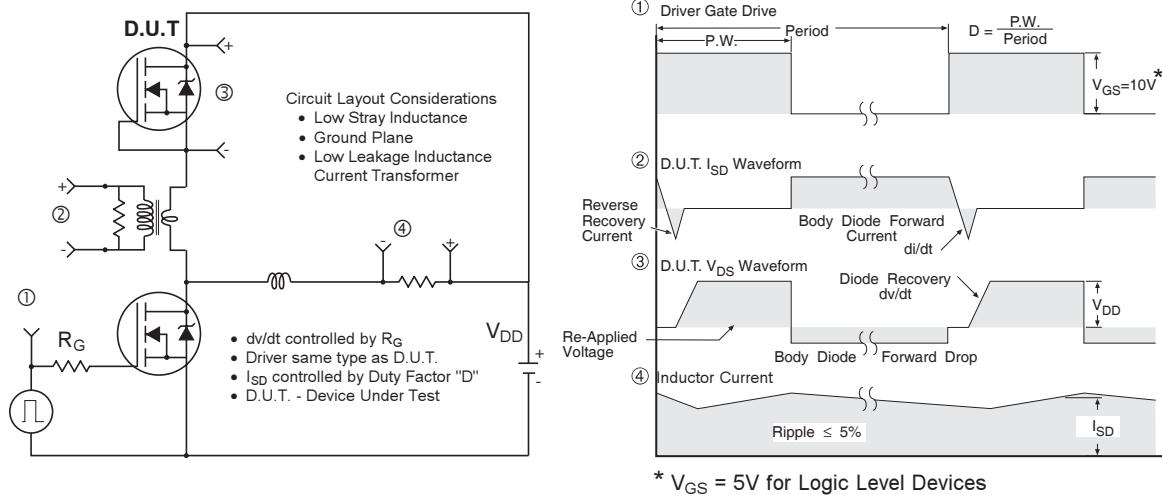
**Fig. 18 -** Typical Recovery Current vs.  $di_f/dt$



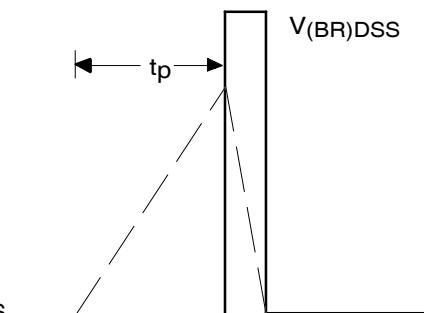
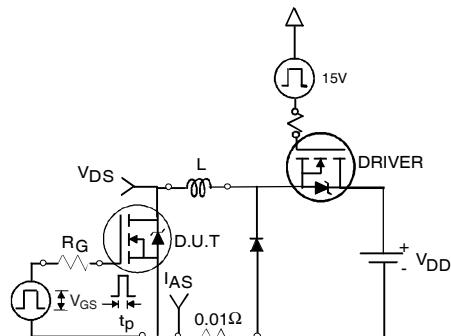
**Fig. 19 -** Typical Stored Charge vs.  $di_f/dt$



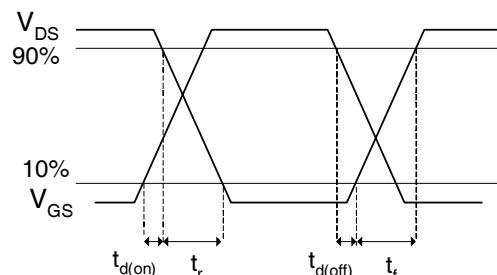
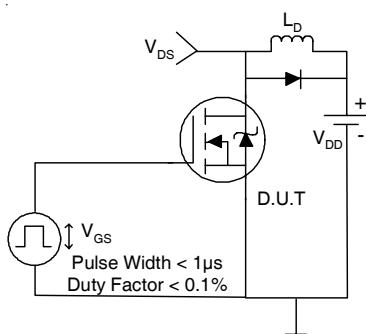
**Fig. 20 -** Typical Stored Charge vs.  $di_f/dt$



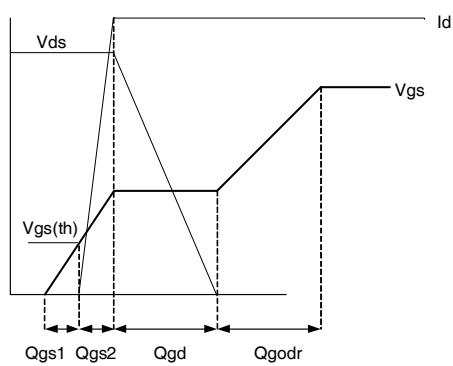
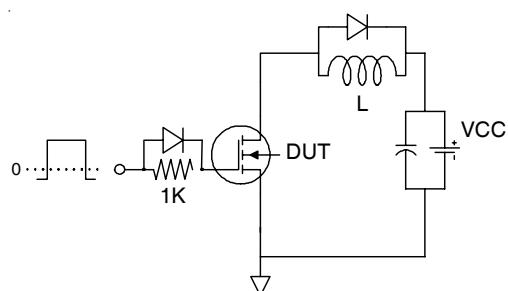
**Fig 20.** Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs



**Fig 21b.** Unclamped Inductive Waveforms



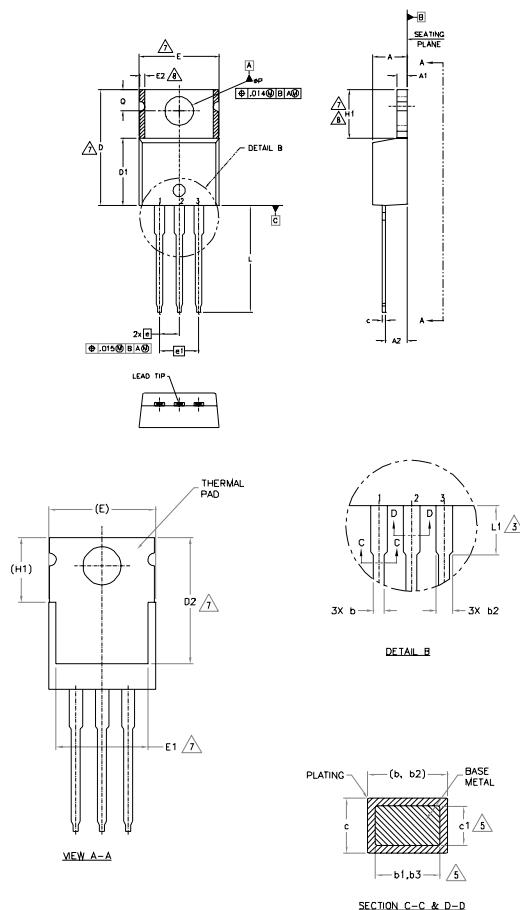
**Fig 22b.** Switching Time Waveforms



**Fig 23b.** 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 (.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 IRRREGULARITIES 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			
	MIN.	MAX.		
A	3.56	4.83	.140 .190	
A1	0.51	1.40	.020 .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	
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	
D1	8.38	9.02	.330 .355	
D2	11.68	12.88	.460 .507	
E	9.65	10.67	.380 .420	
E1	6.86	8.89	.270 .350	
E2	—	0.76	— .030	
e	2.54 BSC		.100 BSC	
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	
RP	3.54	4.08	.139 .161	
Q	2.54	3.42	.100 .135	

### LEAD ASSIGNMENTS

HEXEL

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

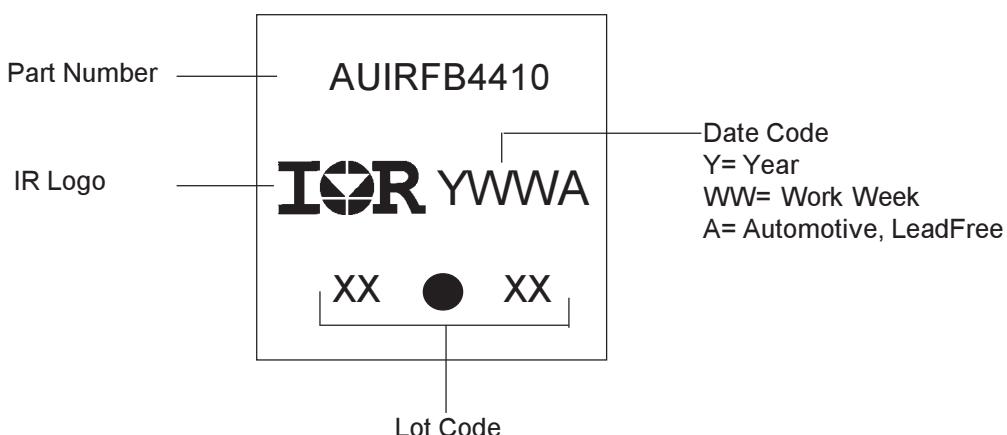
### IGBT CHIPACK

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/>**

**Ordering Information**

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRFB4410	TO-220	Tube	50	AUIRFB4410

## IMPORTANT NOTICE

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IR warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with IR's standard warranty. Testing and other quality control techniques are used to the extent IR deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

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

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