

AUTOMOTIVE GRADE

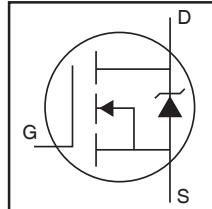
AUIRFS4410Z
AUIRFSL4410Z

Features

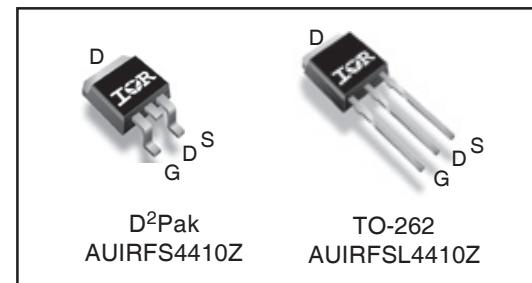
- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to T_{jmax}
- Lead-Free, RoHS Compliant
- Automotive Qualified *

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 a wide variety of other applications.



V_{DSS}	100V
$R_{DS(on)}$ typ.	7.2mΩ
max.	9.0mΩ



G	D	S
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.

	Parameter	Max.	Units
I_D @ $T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$	97	A
I_D @ $T_C = 100^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$	69	
I_{DM}	Pulsed Drain Current ①	390	
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
dv/dt	Peak Diode Recovery ③	16	V/ns
E_{AS} (Thermally limited)	Single Pulse Avalanche Energy ②	242	mJ
I_{AR}	Avalanche Current	See Fig. 14, 15, 22a, 22b,	
E_{AR}	Repetitive Avalanche Energy ④	mJ	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	
	Soldering Temperature, for 10 seconds (1.6mm from case)	300	

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ⑤	—	0.65	°C/W
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount) , D ² Pak ⑦	—	40	

HEXFET® is a registered trademark of International Rectifier.

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

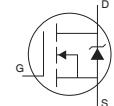
Static Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(\text{BR})\text{DSS}}$	Drain-to-Source Breakdown Voltage	100	—	—	V	$V_{\text{GS}} = 0\text{V}$, $I_D = 250\mu\text{A}$
$\Delta V_{(\text{BR})\text{DSS}}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.12	—	V/ $^\circ\text{C}$	Reference to 25°C , $I_D = 5\text{mA}$ ①
$R_{\text{DS}(\text{on})}$	Static Drain-to-Source On-Resistance	—	7.2	9.0	$\text{m}\Omega$	$V_{\text{GS}} = 10\text{V}$, $I_D = 58\text{A}$ ④
$V_{\text{GS}(\text{th})}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{\text{DS}} = V_{\text{GS}}$, $I_D = 150\mu\text{A}$
g_{fs}	Forward Transconductance	140	—	—	S	$V_{\text{DS}} = 10\text{V}$, $I_D = 58\text{A}$
I_{bss}	Drain-to-Source Leakage Current	—	—	20	μA	$V_{\text{DS}} = 100\text{V}$, $V_{\text{GS}} = 0\text{V}$
		—	—	250		$V_{\text{DS}} = 80\text{V}$, $V_{\text{GS}} = 0\text{V}$, $T_J = 125^\circ\text{C}$
I_{GSS}	Gate-to-Source Forward Leakage	—	—	100	nA	$V_{\text{GS}} = 20\text{V}$
	Gate-to-Source Reverse Leakage	—	—	-100		$V_{\text{GS}} = -20\text{V}$
R_G	Internal Gate Resistance	—	0.70	—	Ω	

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge	—	83	120	nC	$I_D = 58\text{A}$
Q_{gs}	Gate-to-Source Charge	—	19	—		$V_{\text{DS}} = 50\text{V}$
Q_{gd}	Gate-to-Drain ("Miller") Charge	—	27	—		$V_{\text{GS}} = 10\text{V}$ ④
Q_{sync}	Total Gate Charge Sync. ($Q_g - Q_{\text{gd}}$)	—	56	—		$I_D = 58\text{A}$, $V_{\text{DS}} = 0\text{V}$, $V_{\text{GS}} = 10\text{V}$ ④
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	—	16	—	ns	$V_{\text{DD}} = 65\text{V}$
t_r	Rise Time	—	52	—		$I_D = 58\text{A}$
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time	—	43	—		$R_G = 2.7\Omega$
t_f	Fall Time	—	57	—		$V_{\text{GS}} = 10\text{V}$ ④
C_{iss}	Input Capacitance	—	4820	—	pF	$V_{\text{GS}} = 0\text{V}$
C_{oss}	Output Capacitance	—	340	—		$V_{\text{DS}} = 50\text{V}$
C_{rss}	Reverse Transfer Capacitance	—	170	—		$f = 1.0\text{MHz}$, See Fig.5
$C_{\text{oss eff. (ER)}}$	Effective Output Capacitance (Energy Related)	—	420	—		$V_{\text{GS}} = 0\text{V}$, $V_{\text{DS}} = 0\text{V}$ to 80V ⑥, See Fig.11
$C_{\text{oss eff. (TR)}}$	Effective Output Capacitance (Time Related)	—	690	—		$V_{\text{GS}} = 0\text{V}$, $V_{\text{DS}} = 0\text{V}$ to 80V ⑤

Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_s	Continuous Source Current (Body Diode)	—	—	97	A	MOSFET symbol showing the integral reverse p-n junction diode.
I_{SM}	Pulsed Source Current (Body Diode) ①	—	—	390		
V_{SD}	Diode Forward Voltage	—	—	1.3	V	$T_J = 25^\circ\text{C}$, $I_s = 58\text{A}$, $V_{\text{GS}} = 0\text{V}$ ④
t_{rr}	Reverse Recovery Time	—	38	57	ns	$T_J = 25^\circ\text{C}$ $V_R = 85\text{V}$,
		—	46	69		$T_J = 125^\circ\text{C}$ $I_F = 58\text{A}$
Q_{rr}	Reverse Recovery Charge	—	53	80	nC	$T_J = 25^\circ\text{C}$ $\text{di}/\text{dt} = 100\text{A}/\mu\text{s}$ ④
		—	82	120		$T_J = 125^\circ\text{C}$
I_{RRM}	Reverse Recovery Current	—	2.5	—	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:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Limited by T_{Jmax} , starting $T_J = 25^\circ\text{C}$, $L = 0.143\text{mH}$
 $R_G = 25\Omega$, $I_{\text{AS}} = 58\text{A}$, $V_{\text{GS}} = 10\text{V}$. Part not recommended for use above this value.
- ③ $I_{\text{SD}} \leq 58\text{A}$, $\text{di}/\text{dt} \leq 610\text{A}/\mu\text{s}$, $V_{\text{DD}} \leq V_{(\text{BR})\text{DSS}}$, $T_J \leq 175^\circ\text{C}$.
- ④ Pulse width $\leq 400\mu\text{s}$; duty cycle $\leq 2\%$.
- ⑤ $C_{\text{oss eff. (TR)}}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .
- ⑥ $C_{\text{oss eff. (ER)}}$ is a fixed capacitance that gives the same energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .
- ⑦ When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.
- ⑧ R_θ is measured at T_J approximately 90°C .

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		3L-D2 PAK	MSL1
		3L-TO-262	N/A
ESD	Machine Model	Class M4(+/- 800V) ^{†††} AEC-Q101-002	
	Human Body Model	Class H2(+/- 3000V) ^{†††} 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/>

^{††} Exceptions (if any) to AEC-Q101 requirements are noted in the qualification report.

^{†††} Highest passing voltage

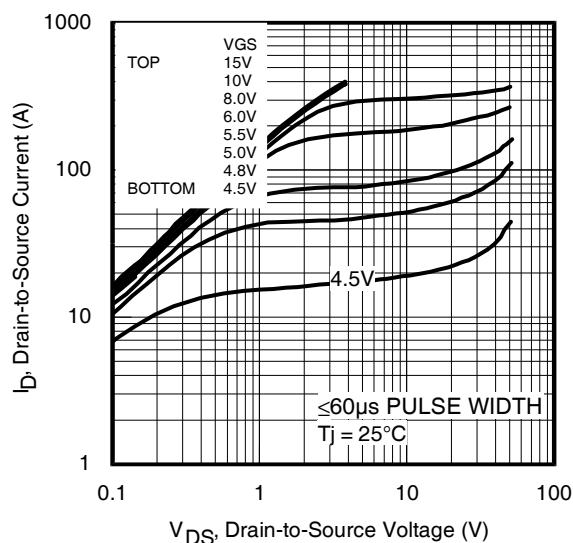


Fig 1. Typical Output Characteristics

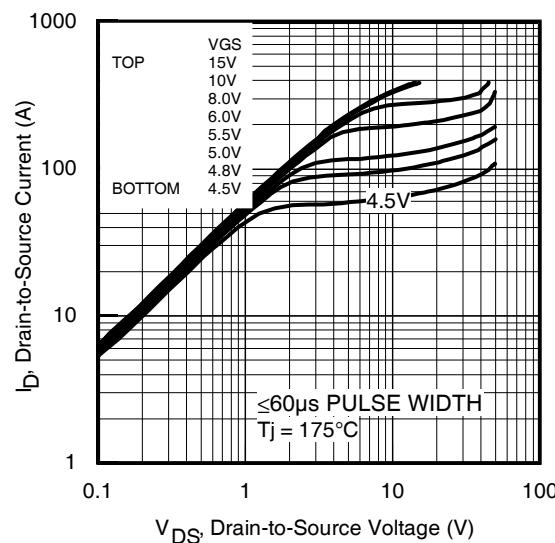


Fig 2. Typical Output Characteristics

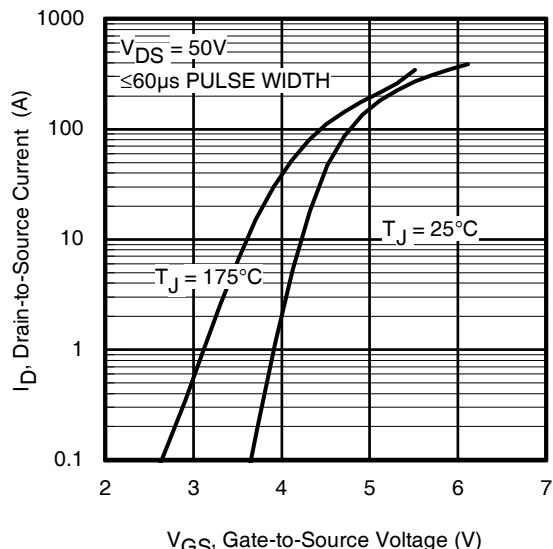


Fig 3. Typical Transfer Characteristics

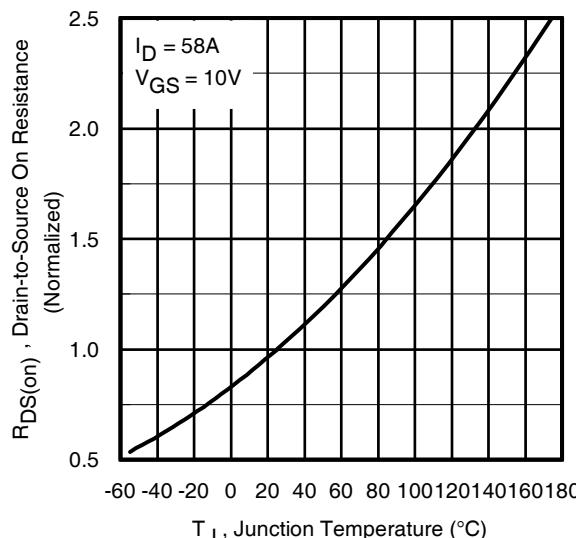


Fig 4. Normalized On-Resistance vs. Temperature

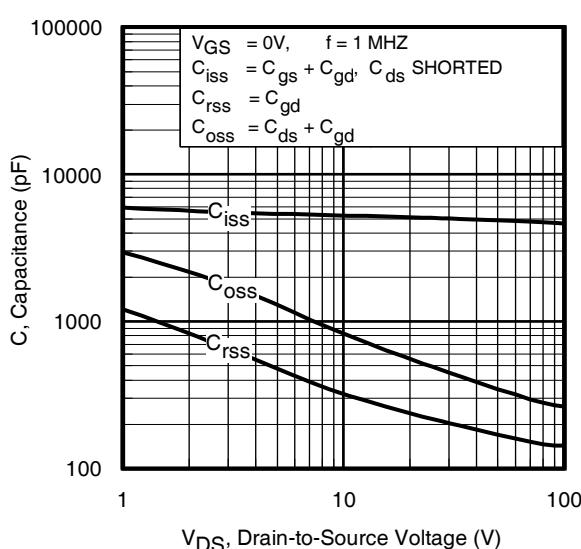


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

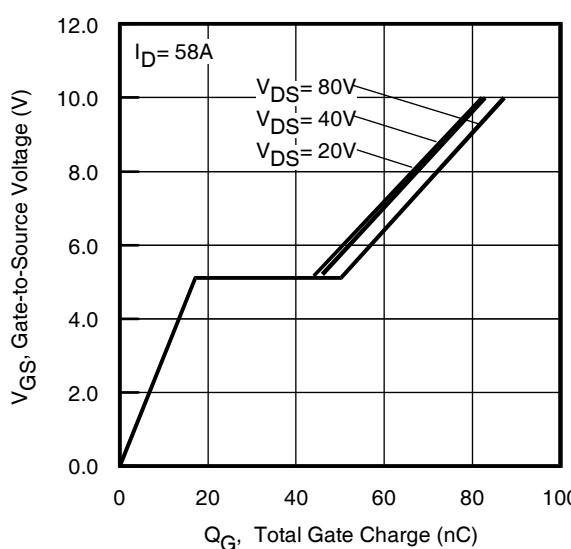


Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage

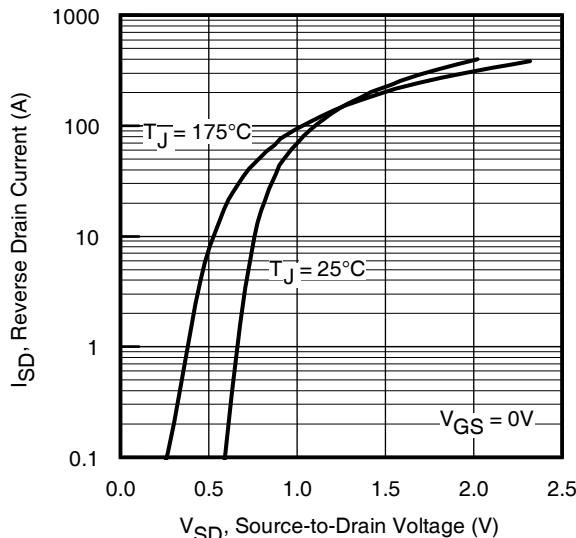


Fig 7. Typical Source-Drain Diode Forward Voltage

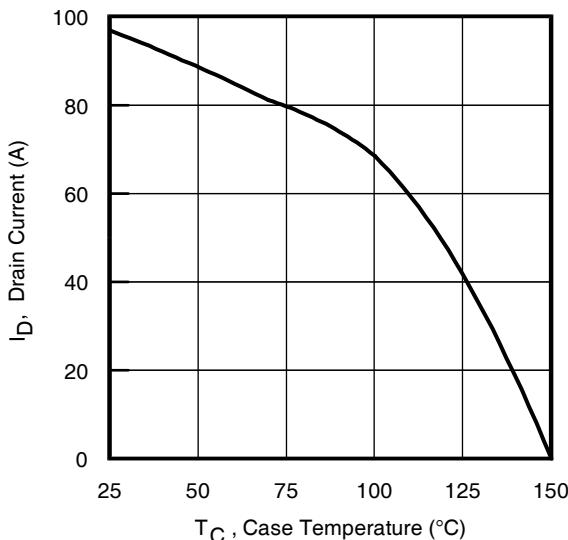


Fig 9. Maximum Drain Current vs. Case Temperature

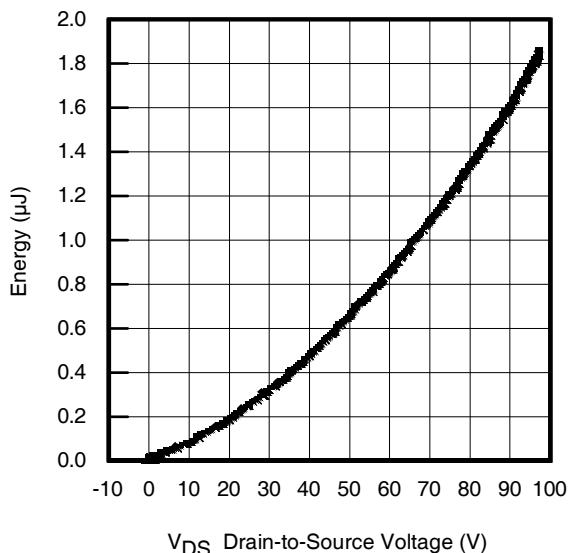


Fig 11. Typical Coss Stored Energy

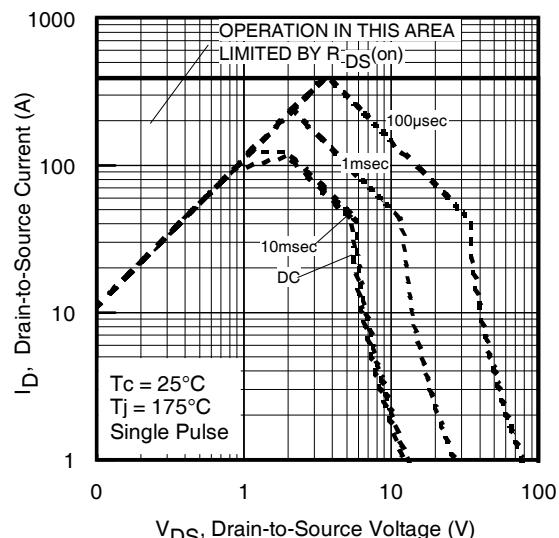


Fig 8. Maximum Safe Operating Area

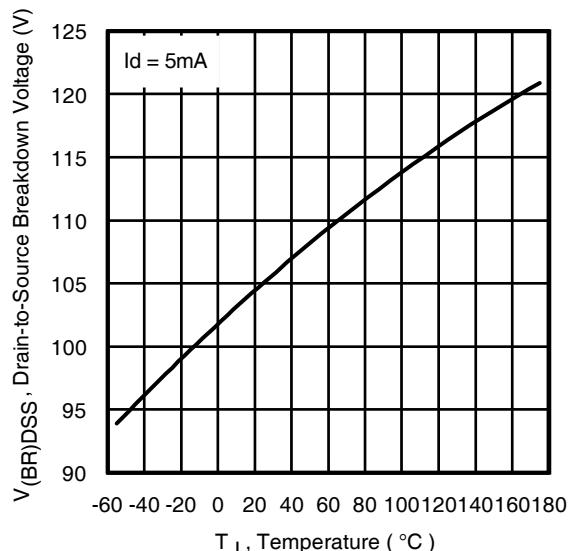


Fig 10. Drain-to-Source Breakdown Voltage

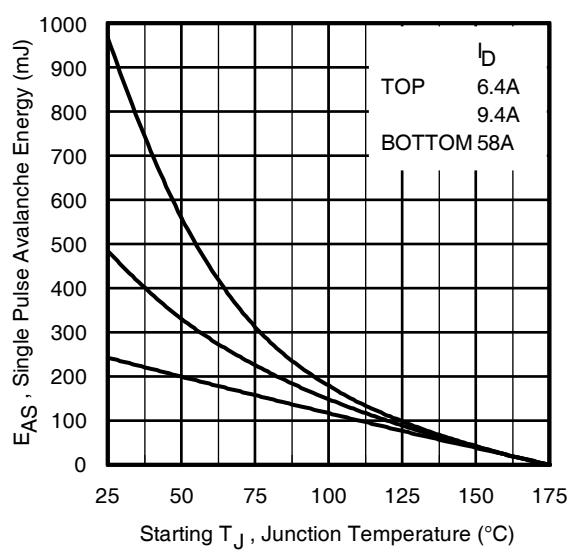


Fig 12. Maximum Avalanche Energy vs. Drain Current

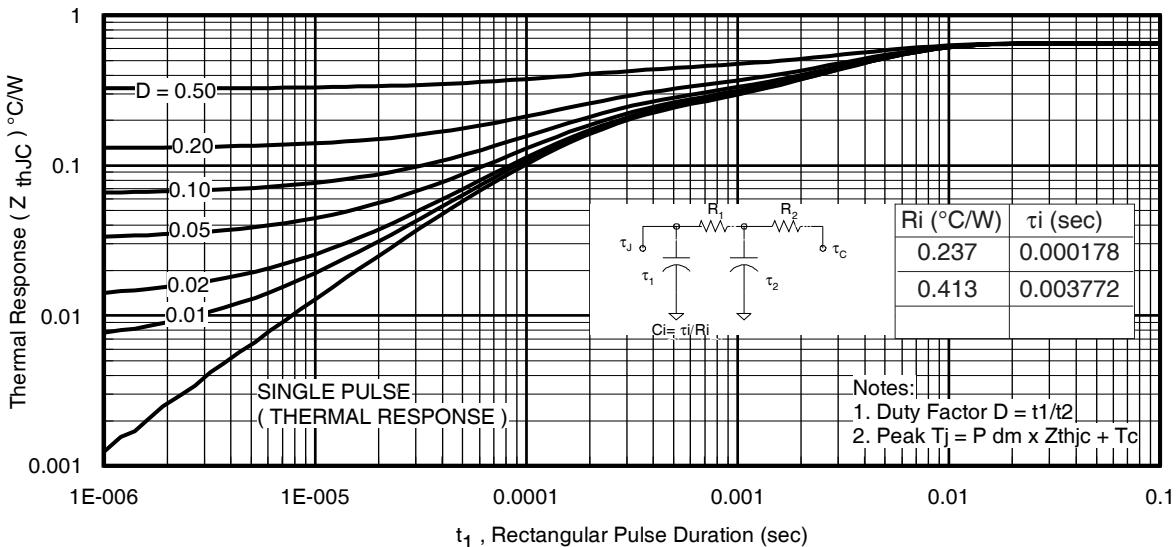


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

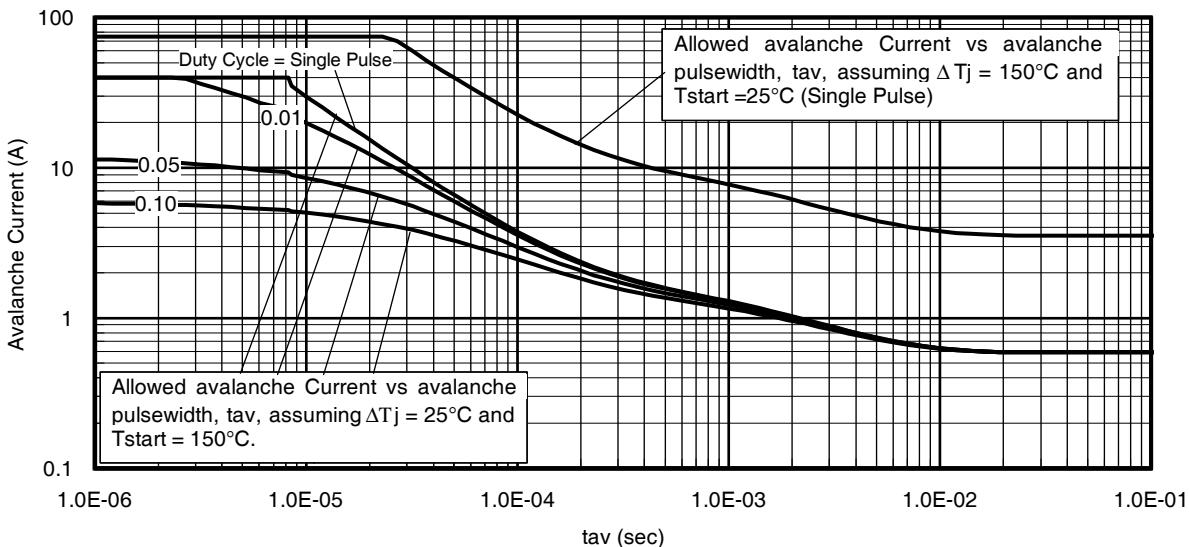


Fig 14. Typical Avalanche Current vs. Pulsewidth

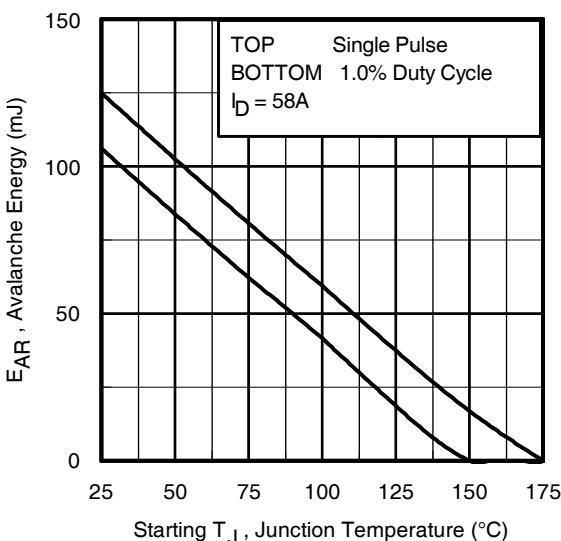


Fig 15. Maximum Avalanche Energy vs. Temperature

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

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 22a, 22b.
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

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

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

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

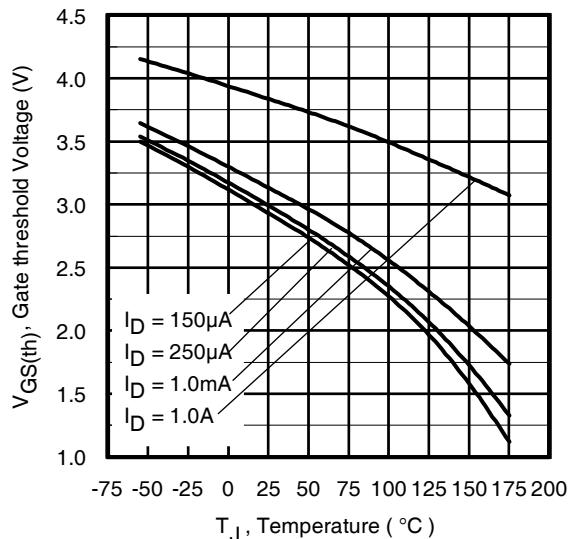


Fig. 16. Threshold Voltage vs. Temperature

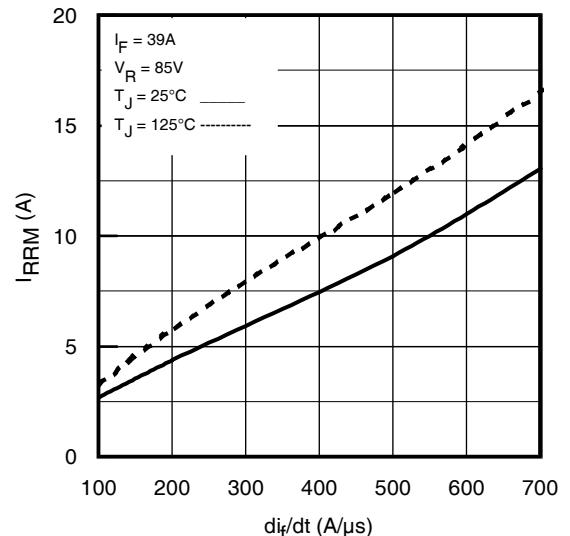


Fig. 17 - Typical Recovery Current vs. di_f/dt

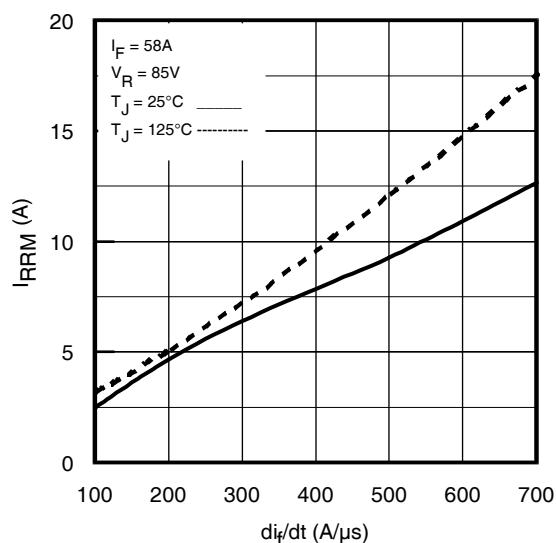


Fig. 18 - Typical Recovery Current vs. di_f/dt

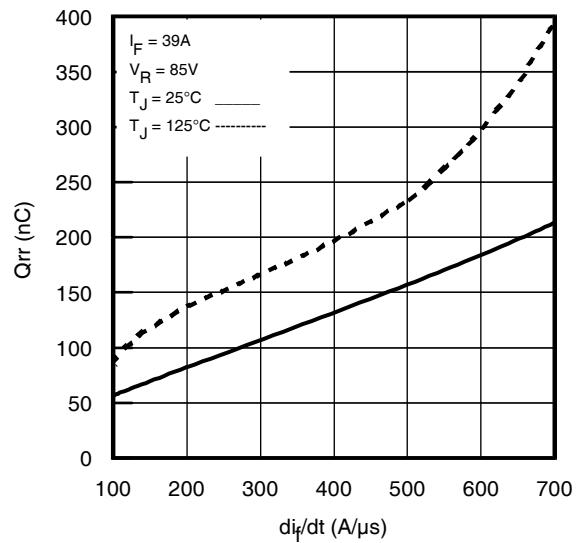


Fig. 19 - Typical Stored Charge vs. di_f/dt

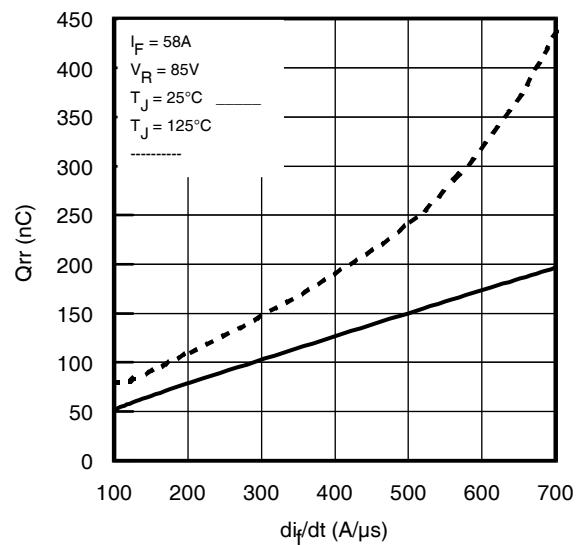


Fig. 20 - Typical Stored Charge vs. di_f/dt

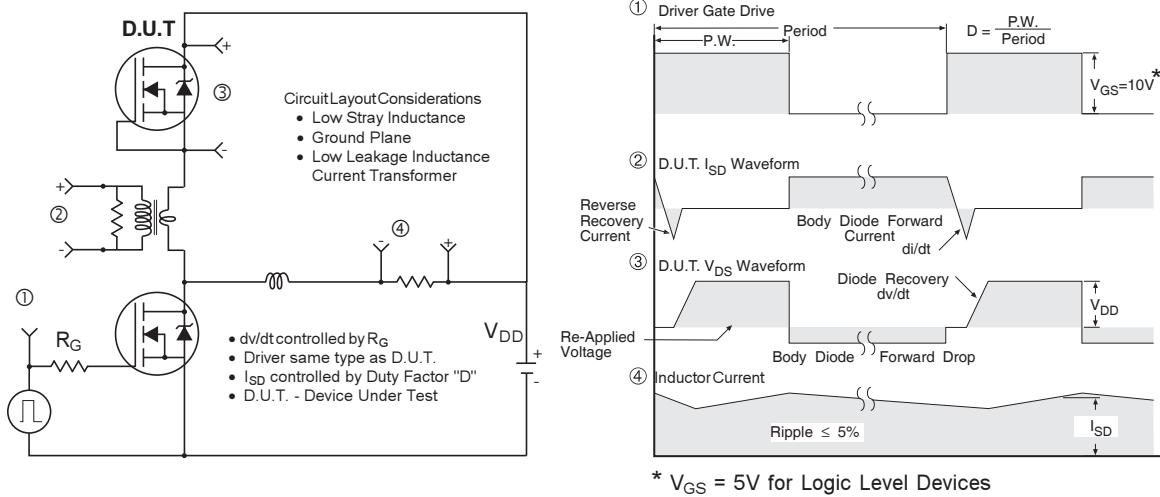


Fig 21. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

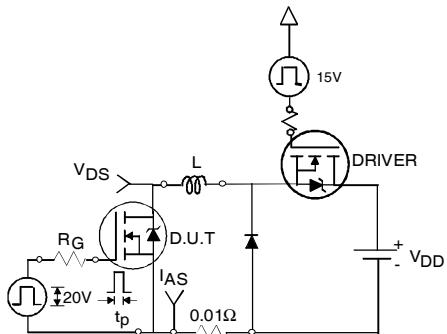


Fig 22a. Unclamped Inductive Test Circuit

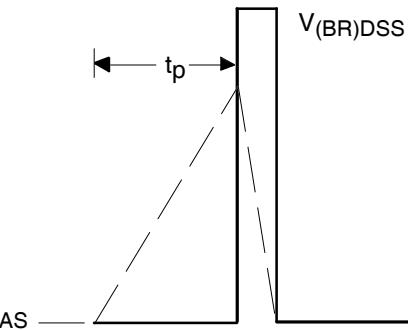


Fig 22b. Unclamped Inductive Waveforms

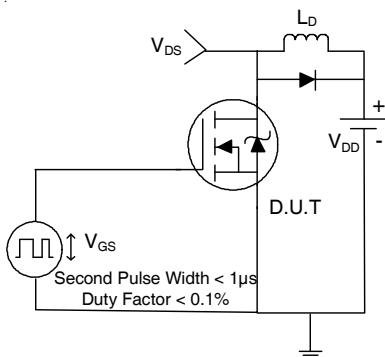


Fig 23a. Switching Time Test Circuit

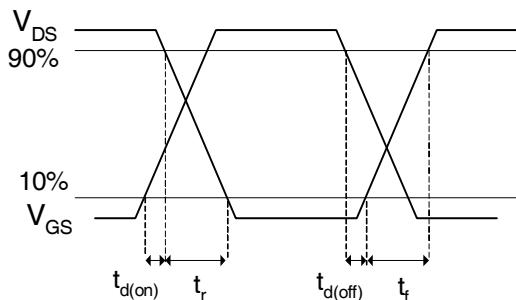


Fig 23b. Switching Time Waveforms

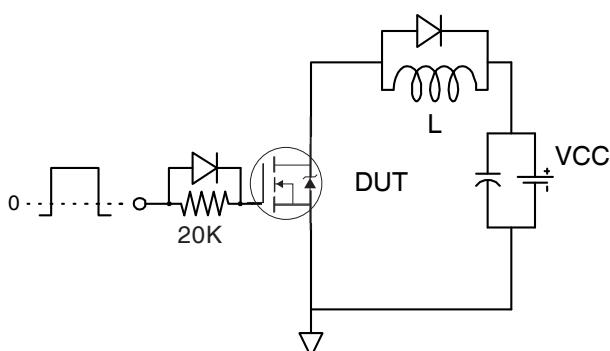


Fig 24a. Gate Charge Test Circuit

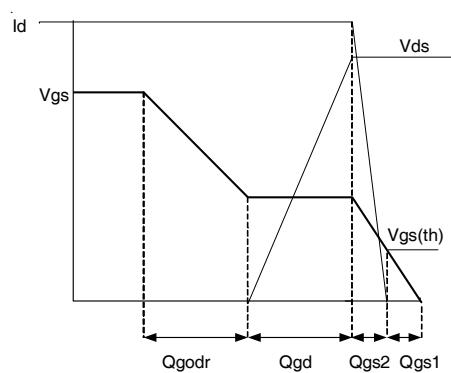
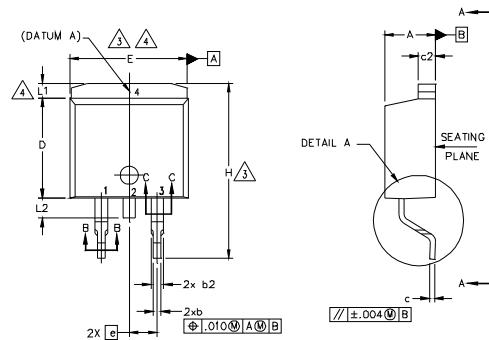


Fig 24b. Gate Charge Waveform

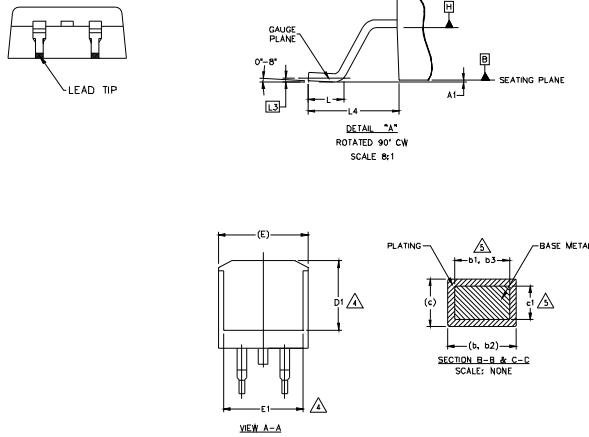
D²Pak (TO-263AB) Package Outline

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 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	—	1.65	—	.066	4	
L2	1.27	1.78	—	.070		
L3	0.25	BSC	.010	BSC		
L4	4.78	5.28	.188	.208		

LEAD ASSIGNMENTS

HEXFET

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

IGBTs, CoPACk

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

DIODES

1. ANODE *
- 2, 4. CATHODE
3. ANODE

* PART DEPENDENT.

D²Pak Part Marking Information

Part Number

AUFS4410Z

Date Code

Y= Year

WW= Work Week

A= Automotive, Lead Free

IR Logo

IR YWWA

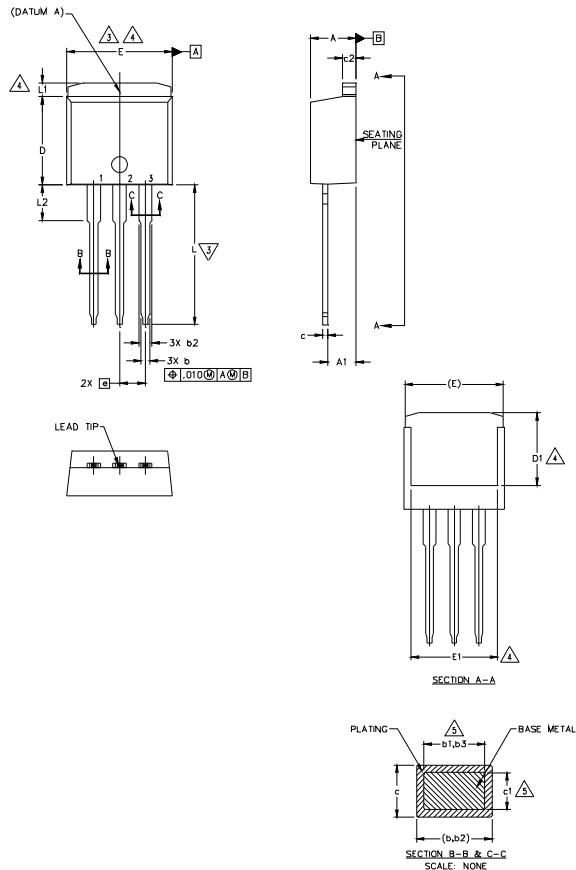
XX ● XX

Lot Code

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.

S Y M B O L	DIMENSIONS				N O T E S	
	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		

LEAD ASSIGNMENTS

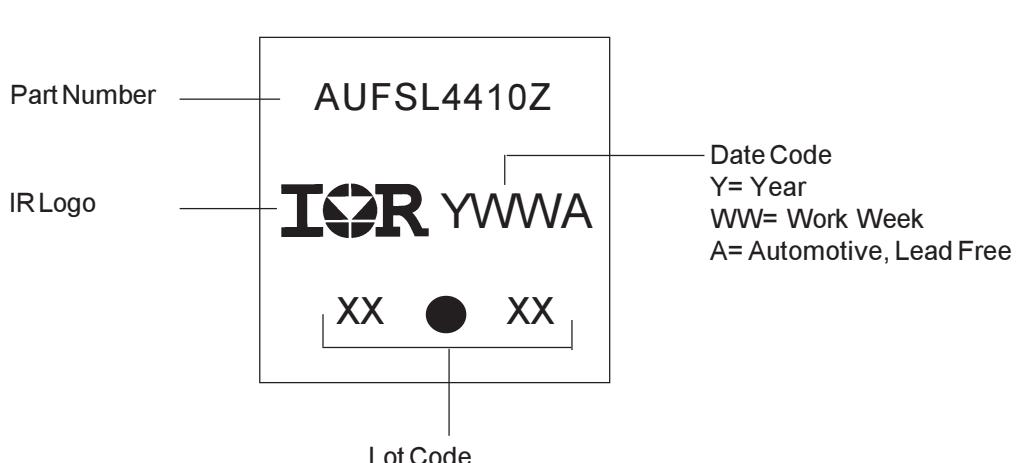
HEXFET

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

IGBTs, CoPACK

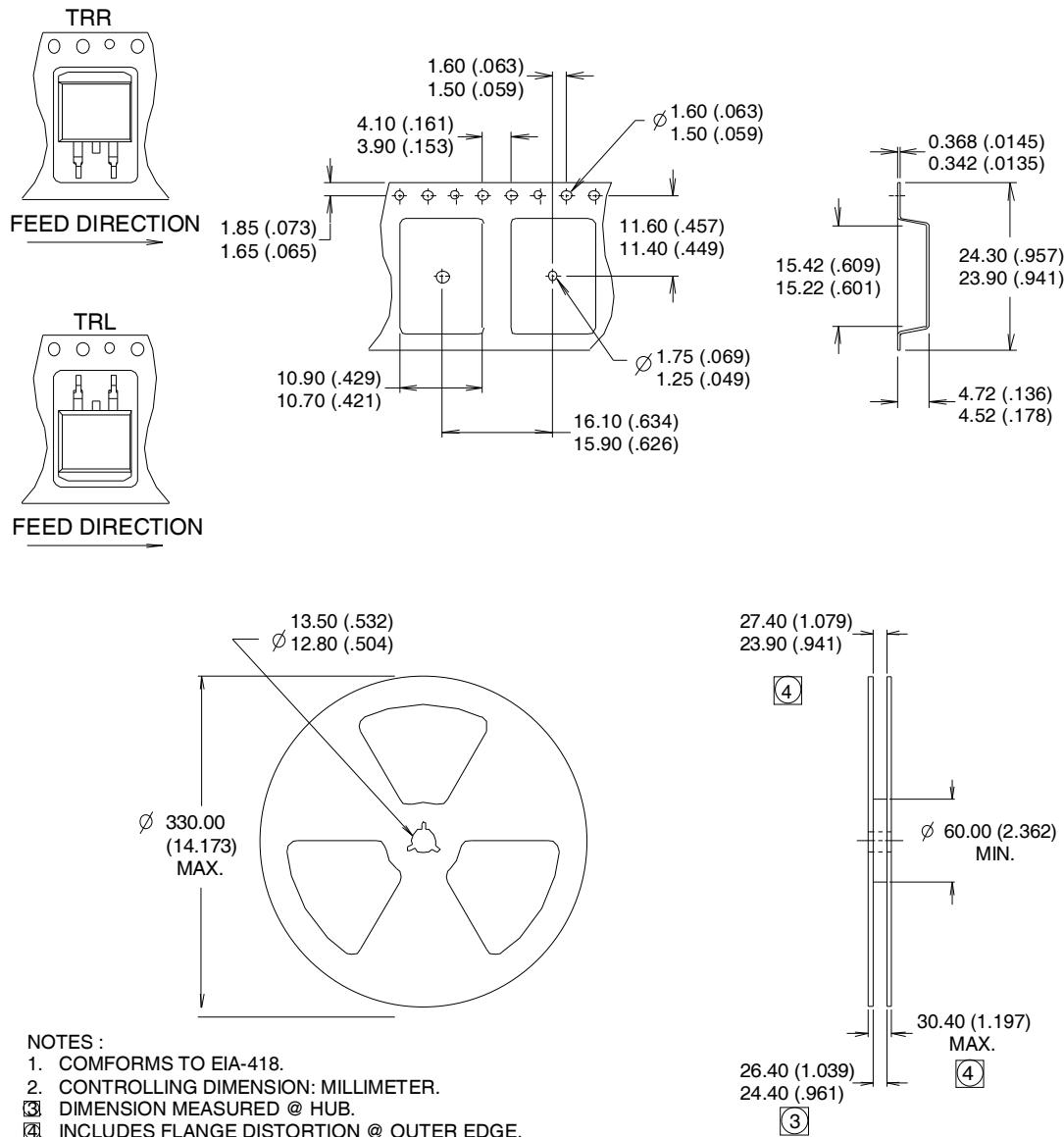
1. GATE
2. COLLECTOR
3. Emitter
4. COLLECTOR

TO-262 Part Marking Information

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

D²Pak (TO-263AB) Tape & Reel Information

Dimensions are shown in millimeters (inches)



Ordering Information

Base part	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRFSL4410Z	TO-262	Tube	50	AUIRFSL4410Z
AUIRFS4410Z	D2Pak	Tube	50	AUIRFS4410Z
		Tape and Reel Left	800	AUIRFS4410ZTRL
		Tape and Reel Right	800	AUIRFS4410ZTRR

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WORLD HEADQUARTERS:

101 N. Sepulveda Blvd., El Segundo, California 90245

Tel: (310) 252-7105