

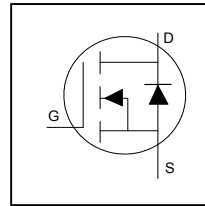
**Features**

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

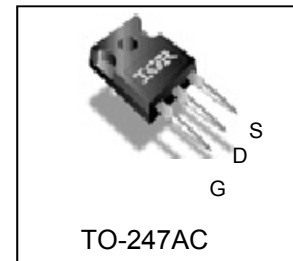
**Description**

Specifically designed for Automotive applications, this HEXFET® Power MOSFETs utilizes the latest processing techniques to achieve low on-resistance per silicon area. This benefit combined with the fast switching speed and ruggedized device design that HEXFET power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in Automotive and a wide variety of other applications.

HEXFET® Power MOSFET



$V_{DSS}$	<b>300V</b>
$R_{DS(on)}$ typ.	<b>56mΩ</b>
	<b>69mΩ</b>
$I_D$	<b>38A</b>



<b>G</b>	<b>D</b>	<b>S</b>
Gate	Drain	Source

**Ordering Information**

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRFP4409	TO-247AC	Tube	25	AUIRFP4409

**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
$I_D @ T_C = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$	38	A
$I_D @ T_C = 100^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$	27	
$I_{DM}$	Pulsed Drain Current ①	152	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	341	W
	Linear Derating Factor	2.3	W/°C
$V_{GS}$	Gate-to-Source Voltage	± 20	V
$E_{AS}$ (Thermally limited)	Single Pulse Avalanche Energy ②	541	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 (1.1 N·m)	

**Thermal Resistance**

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ③	—	0.44	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat Greased Surface	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient ④	—	40	

HEXFET® is a registered trademark of International Rectifier.  
\*Qualification standards can be found at <http://www.irf.com/>

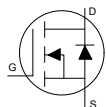
**Static @ T<sub>J</sub> = 25°C (unless otherwise specified)**

	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)DSS</sub>	Drain-to-Source Breakdown Voltage	300	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA
ΔV <sub>(BR)DSS</sub> /ΔT <sub>J</sub>	Breakdown Voltage Temp. Coefficient	—	0.24	—	V/°C	Reference to 25°C, I <sub>D</sub> = 3.5mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-Resistance	—	56	69	mΩ	V <sub>GS</sub> = 10V, I <sub>D</sub> = 24A ④
V <sub>GS(th)</sub>	Gate Threshold Voltage	3.0	—	5.0	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA
I <sub>DSS</sub>	Drain-to-Source Leakage Current	—	—	20	μA	V <sub>DS</sub> = 300V, V <sub>GS</sub> = 0V
		—	—	250		V <sub>DS</sub> = 300V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 125°C
I <sub>GSS</sub>	Gate-to-Source Forward Leakage	—	—	100	nA	V <sub>GS</sub> = 20V
	Gate-to-Source Reverse Leakage	—	—	-100		V <sub>GS</sub> = -20V
R <sub>G</sub>	Gate Resistance	—	1.3	—	Ω	

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

g <sub>fs</sub>	Forward Transconductance	45	—	—	S	V <sub>DS</sub> = 50V, I <sub>D</sub> = 24A
Q <sub>g</sub>	Total Gate Charge	—	83	125	nC	I <sub>D</sub> = 24A
Q <sub>gs</sub>	Gate-to-Source Charge	—	28	42		V <sub>DS</sub> = 150V
Q <sub>gd</sub>	Gate-to-Drain Charge	—	26	39		V <sub>GS</sub> = 10V
t <sub>d(on)</sub>	Turn-On Delay Time	—	18	—	ns	V <sub>DD</sub> = 195V
t <sub>r</sub>	Rise Time	—	23	—		I <sub>D</sub> = 24A
t <sub>d(off)</sub>	Turn-Off Delay Time	—	34	—		R <sub>G</sub> = 2.2Ω
t <sub>f</sub>	Fall Time	—	20	—		V <sub>GS</sub> = 10V
C <sub>iss</sub>	Input Capacitance	—	5168	—	pF	V <sub>GS</sub> = 0V
C <sub>oss</sub>	Output Capacitance	—	300	—		V <sub>DS</sub> = 50V
C <sub>rss</sub>	Reverse Transfer Capacitance	—	77	—		f = 1.0MHz
C <sub>oss eff.(ER)</sub>	Effective Output Capacitance (Energy Related)	—	196	—		V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 240V <sup>⑥</sup>
C <sub>oss eff.(TR)</sub>	Output Capacitance (Time Related)	—	265	—		See Fig.11
						V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 240V <sup>⑤</sup>

**Diode Characteristics**

	Parameter	Min.	Typ.	Max.	Units	Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode) ①	—	—	40	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I <sub>SM</sub>	Pulsed Source Current (Body Diode) ①	—	—	160		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.3	V	T <sub>J</sub> = 25°C, I <sub>S</sub> = 24A, V <sub>GS</sub> = 0V ④
t <sub>rr</sub>	Reverse Recovery Time	—	302	—	ns	T <sub>J</sub> = 25°C V <sub>DD</sub> = 255V
		—	379	—		T <sub>J</sub> = 125°C I <sub>F</sub> = 24A,
Q <sub>rr</sub>	Reverse Recovery Charge	—	1739	—	nC	T <sub>J</sub> = 25°C di/dt = 100A/μs ④
		—	2497	—		T <sub>J</sub> = 125°C
I <sub>RSM</sub>	Reverse Recovery Current	—	13	—	A	T <sub>J</sub> = 25°C

**Notes:**

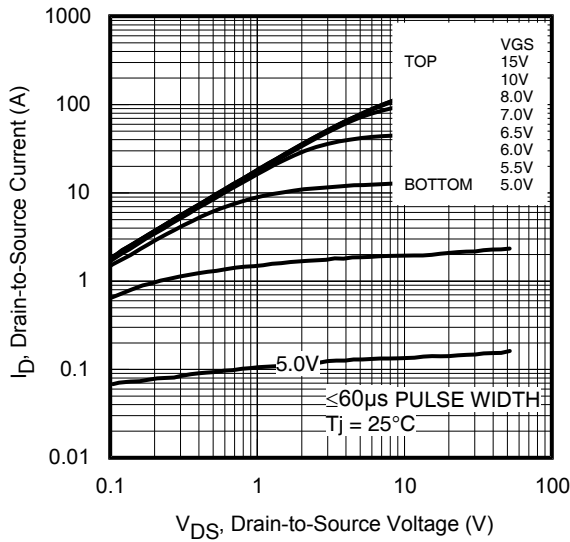
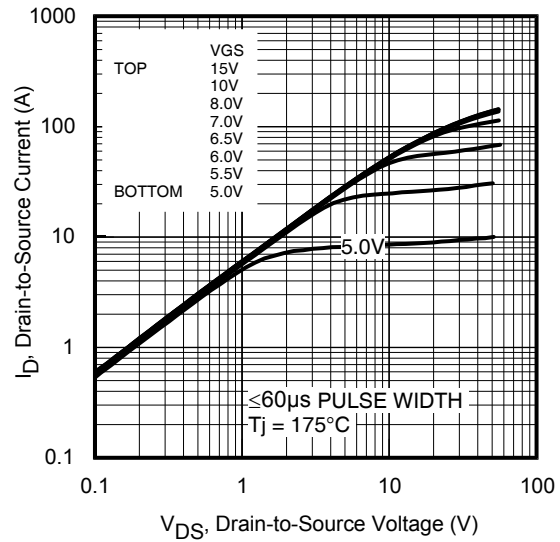
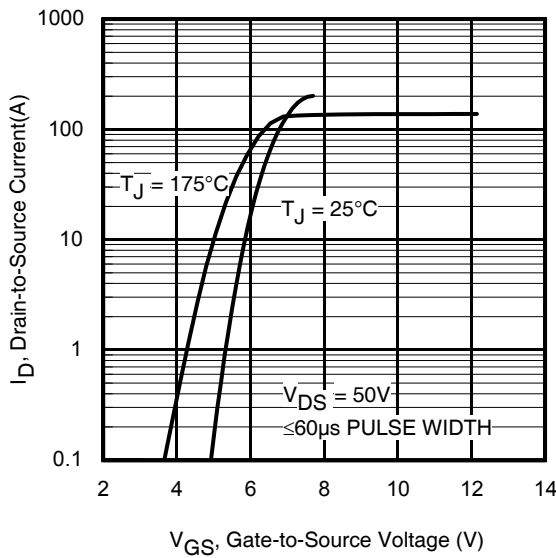
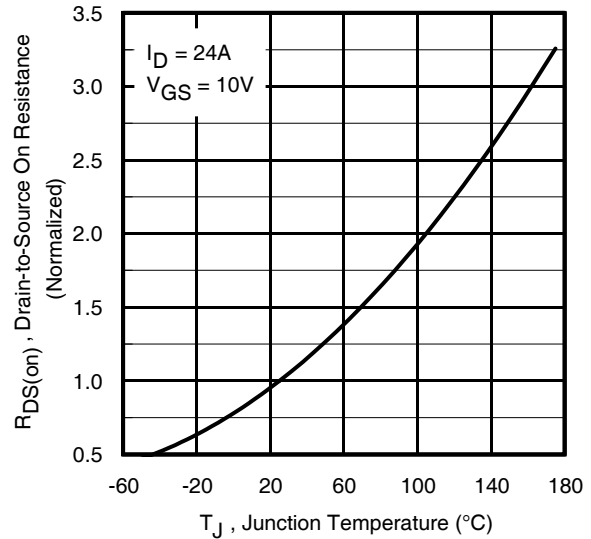
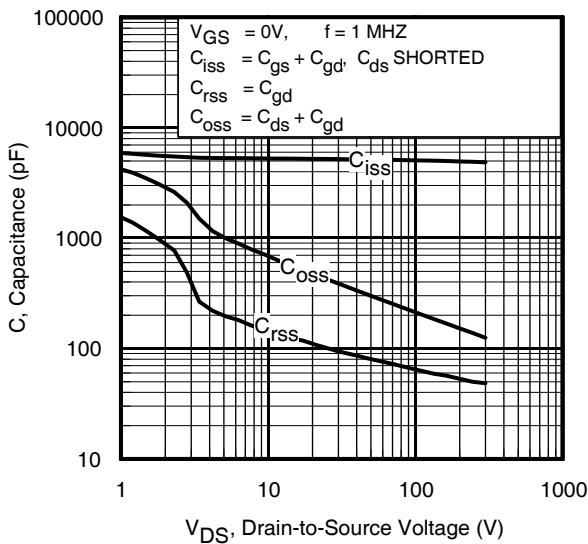
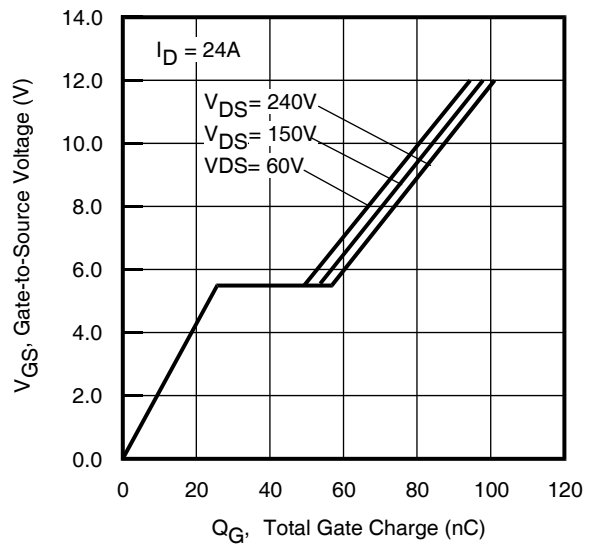
- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Recommended max EAS limit, starting T<sub>J</sub> = 25°C, L = 2.05mH, R<sub>G</sub> = 50Ω, I<sub>AS</sub> = 24A, V<sub>GS</sub> = 10V.
- ③ I<sub>SD</sub> ≤ 24A, di/dt ≤ 1771A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>J</sub> ≤ 175°C.
- ④ Pulse width ≤ 400μs; duty cycle ≤ 2%.
- ⑤ C<sub>oss eff. (TR)</sub> 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>.
- ⑥ C<sub>oss eff. (ER)</sub> is a fixed capacitance that gives the same energy as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V<sub>DSS</sub>.
- 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 [http://www.irf.com/technical-info/app\\_notes/an-994.pdf](http://www.irf.com/technical-info/app_notes/an-994.pdf)
- ⑧ R<sub>θ</sub> is measured at T<sub>J</sub> approximately 90°C

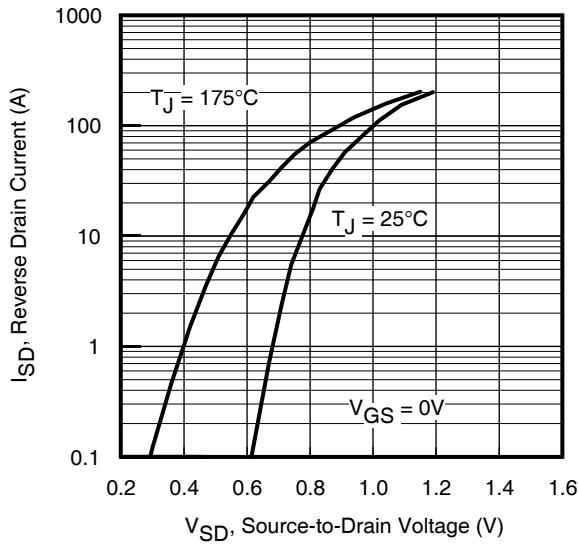
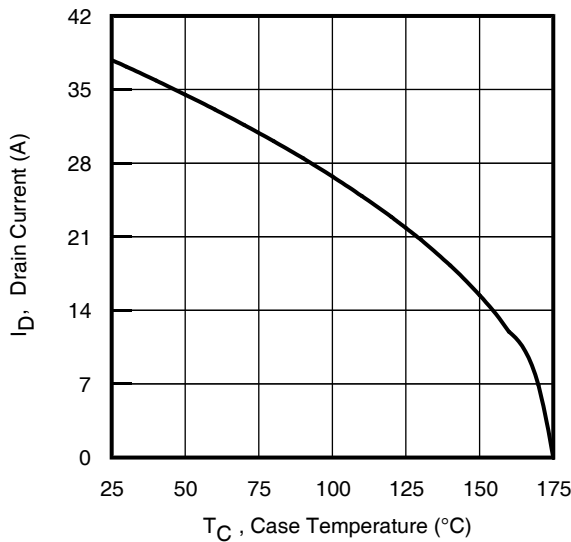
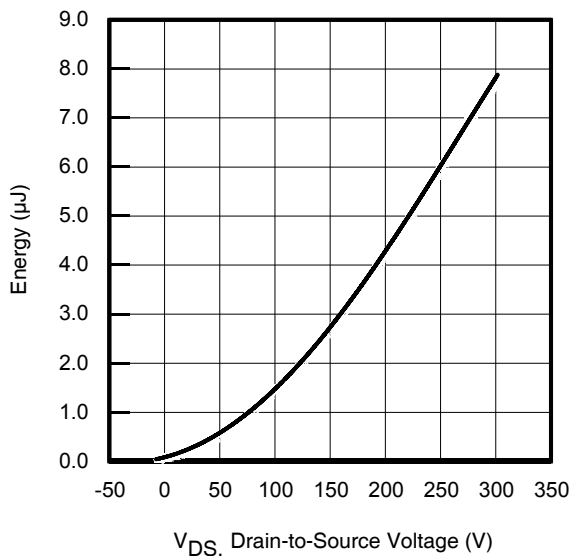
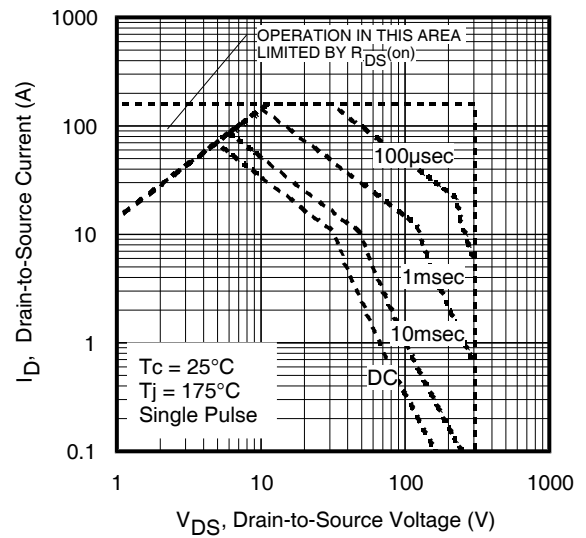
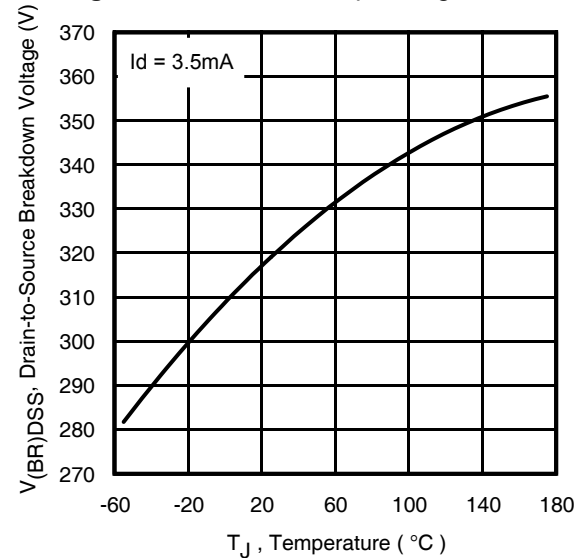
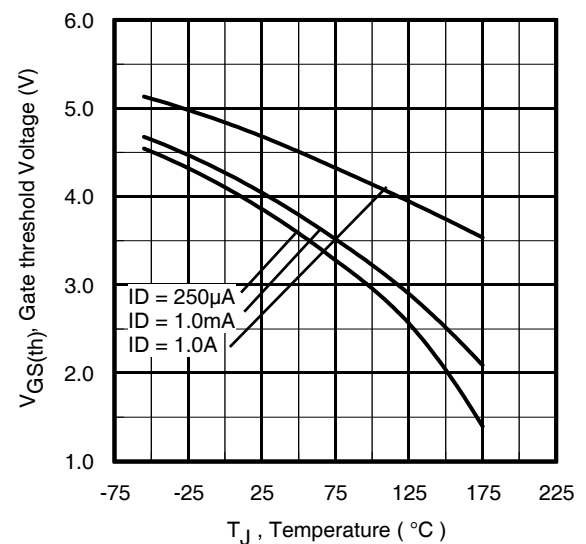
**Qualification Information<sup>†</sup>**

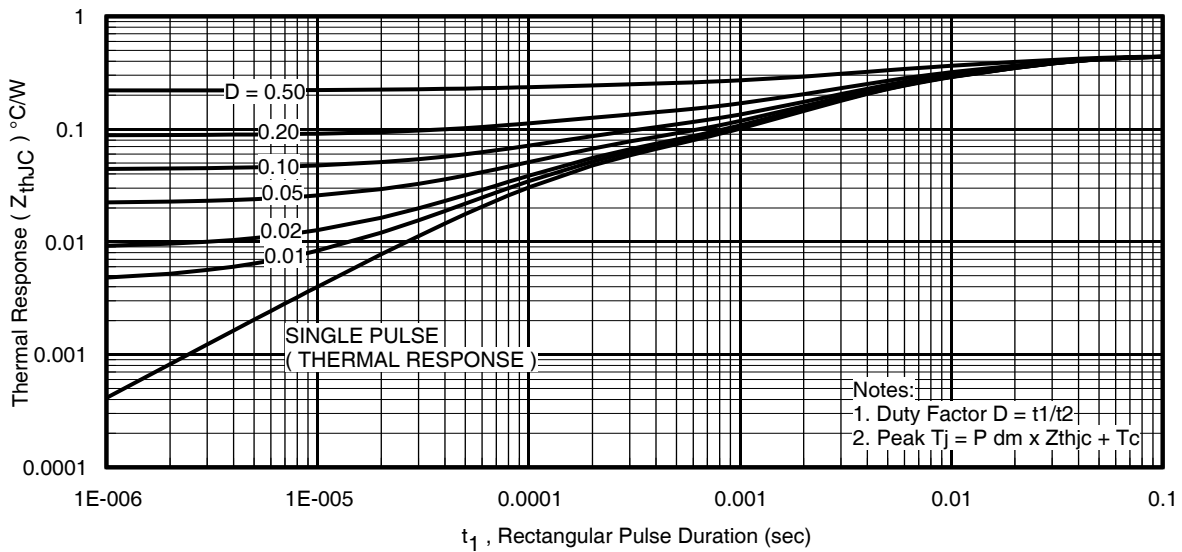
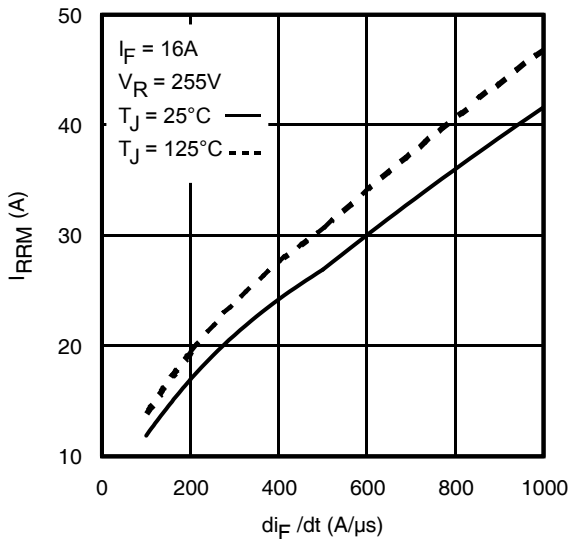
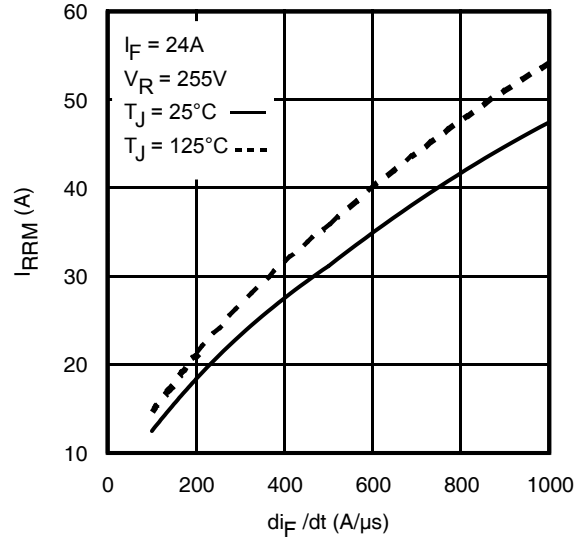
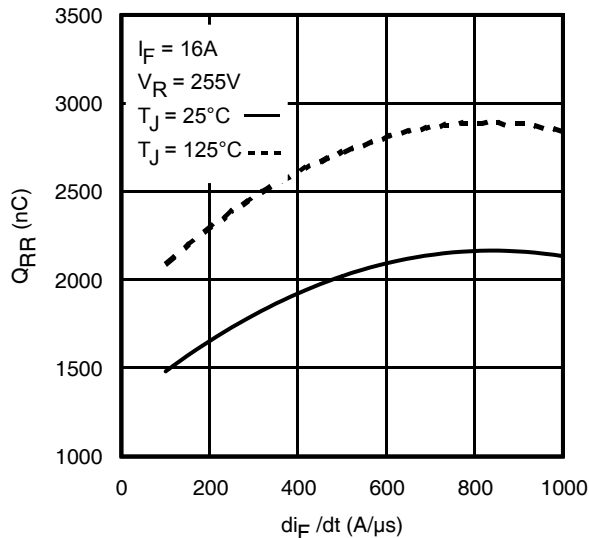
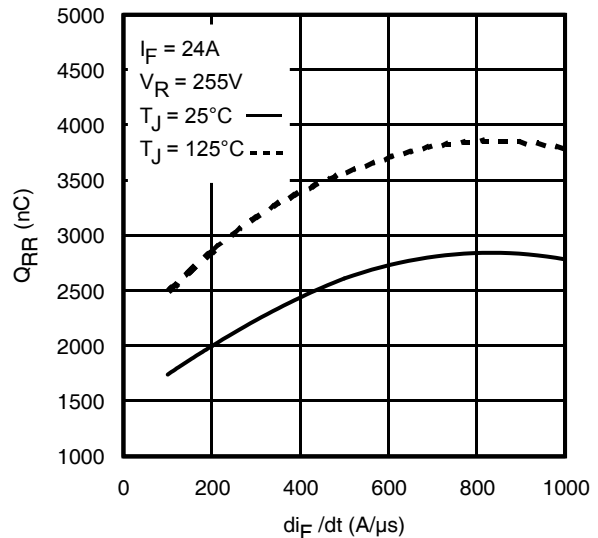
<b>Qualification Level</b>		Automotive (per AEC-Q101)	
		Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
<b>Moisture Sensitivity Level</b>		TO-247AC	N/A
<b>ESD</b>	Machine Model	Class M4 (+/- 500V) <sup>††</sup> AEC-Q101-002	
	Human Body Model	Class H2 (+/- 4000V) <sup>††</sup> AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 2000) <sup>††</sup> AEC-Q101-005	
<b>RoHS Compliant</b>		Yes	

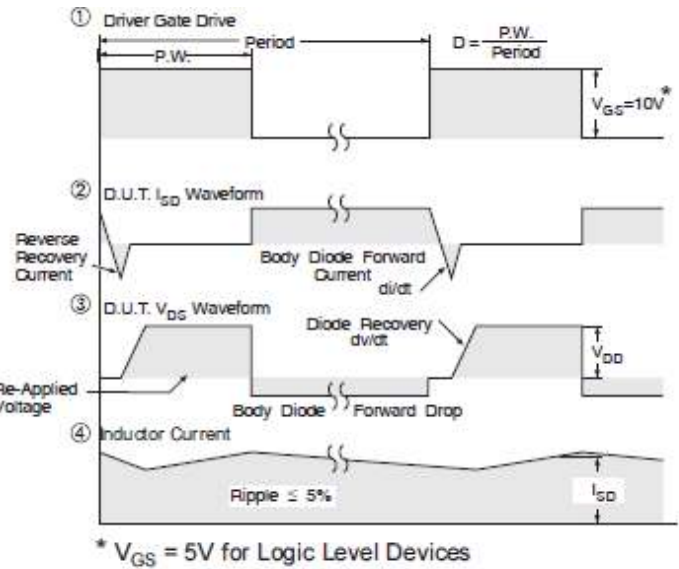
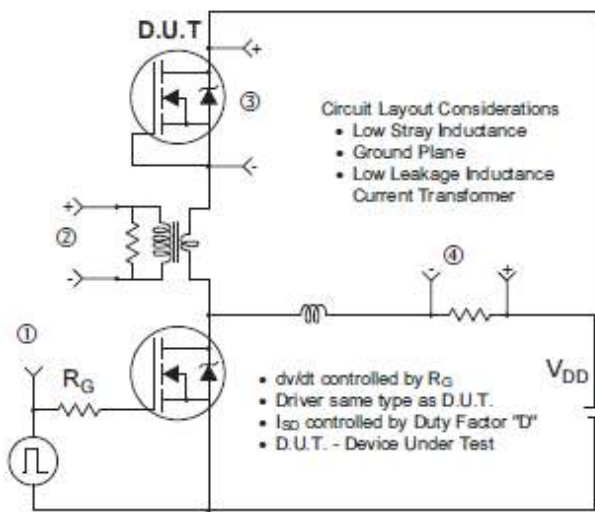
† Qualification standards can be found at International Rectifier's web site: <http://www.irf.com/>

†† Highest passing voltage.

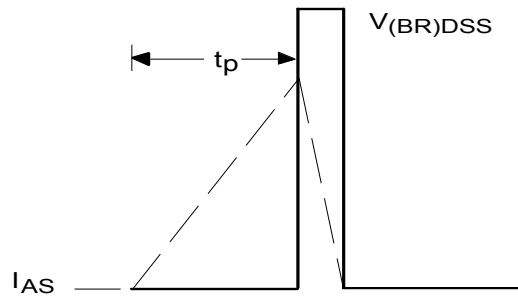
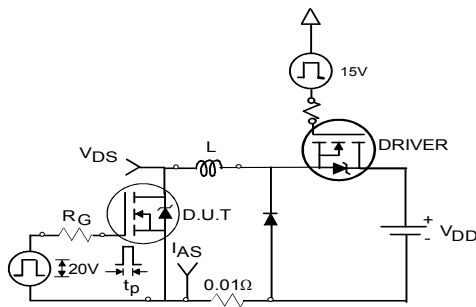

**Fig 1. Typical Output Characteristics**

**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  $C_{oss}$  Stored Energy**

**Fig 8. Maximum Safe Operating Area**

**Fig 10. Drain-to-Source Breakdown Voltage**

**Fig 12. Threshold Voltage vs. Temperature**


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

**Fig 14.** Typical Recovery Current vs.  $di_F/dt$ 

**Fig 15.** Typical Recovery Current vs.  $di_F/dt$ 

**Fig 16.** Typical Stored Charge vs.  $di_F/dt$ 

**Fig 17.** Typical Stored Charge vs.  $di_F/dt$

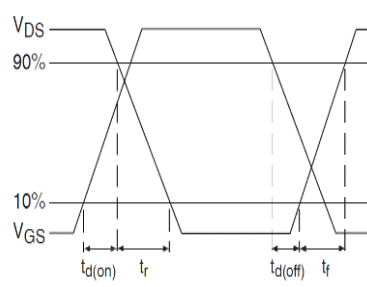
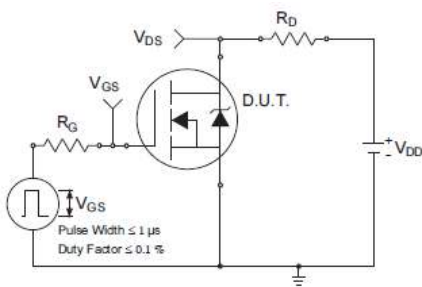


**Fig 18.** Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs



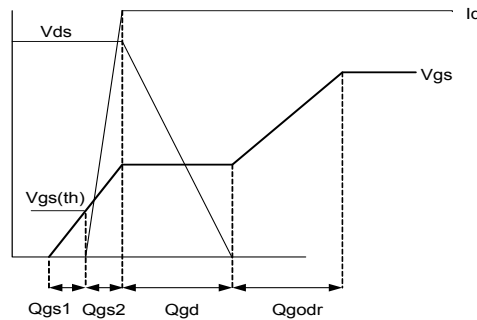
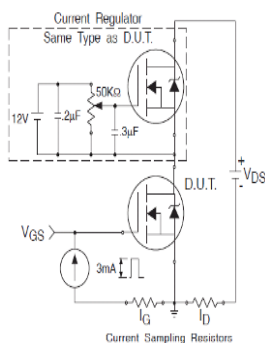
**Fig 19a.** Unclamped Inductive Test Circuit

**Fig 19b.** Unclamped Inductive Waveforms



**Fig 20a.** Switching Time Test Circuit

**Fig 20b.** Switching Time Waveforms

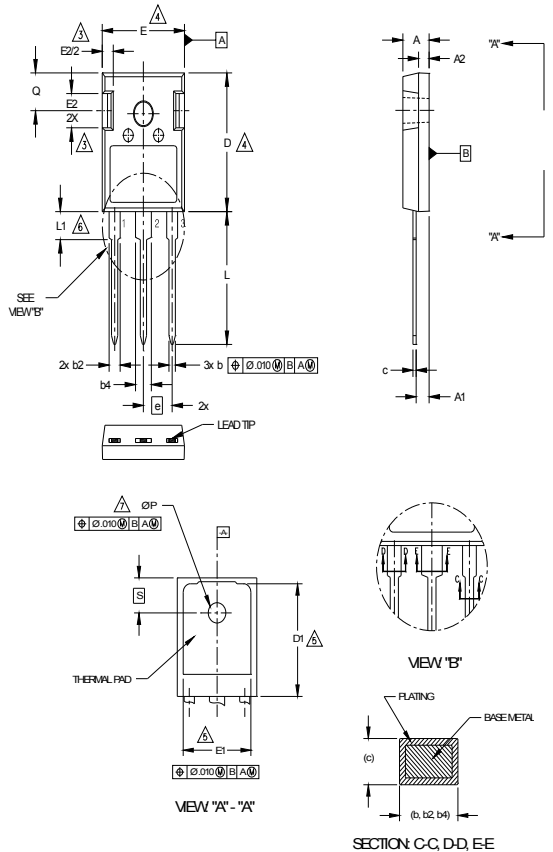


**Fig 21a.** Gate Charge Test Circuit

**Fig 21b.** Gate Charge Waveform

## TO-247AC Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.190	.204	4.83	5.20	
A1	.090	.100	2.29	2.54	
A2	.075	.085	1.91	2.16	
b	.042	.052	1.07	1.33	
b2	.075	.094	1.91	2.41	
b4	.113	.133	2.87	3.38	
c	.022	.026	0.55	0.68	
D	.819	.830	20.80	21.10	4
D1	.640	.694	16.25	17.65	5
E	.620	.635	15.75	16.13	4
E1	.512	.570	13.00	14.50	
E2	.145	.196	3.68	5.00	
e	.215 Typical		5.45 Typical		
L	.780	.800	19.80	20.32	
L1	.161	.173	4.10	4.40	
phi P	.138	.143	3.51	3.65	
Q	.216	.236	5.49	6.00	
S	.238	.248	6.04	6.30	

**LEAD ASSIGNMENTS**
**HEXFET**

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

**IGBTs, CoPACK**

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

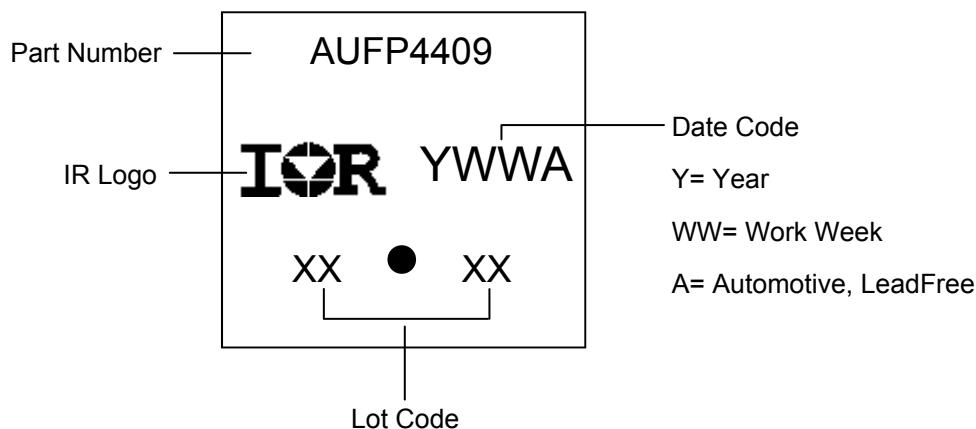
**DIODES**

- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

**NOTES:**

- 1 DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
- 2 DIMENSIONS ARE SHOWN IN INCHES AND MILLIMETERS.
- 3 CONTOUR OF SLOT OPTIONAL.
- 4 DIMENSION D & 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 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
- 6 LEAD FINISH UNCONTROLLED IN L1.
- 7 phi P TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.

## TO-247AC Part Marking Information



TO-247AC package is not recommended for Surface Mount Application.

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



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<http://www.irf.com/technical-info/>

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