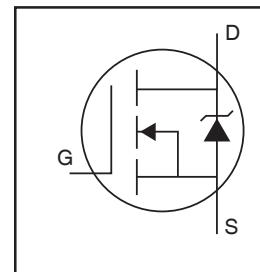


## Features

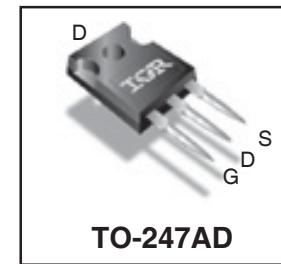
- Advanced Process Technology
- Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to  $T_{jmax}$
- Lead-Free, RoHS Compliant
- Automotive Qualified \*

## Description

Specifically designed for Automotive applications, this HEXFET® Power 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.



$V_{(BR)DSS}$	24V
$R_{DS(on)}$ typ.	1.25mΩ
	max. 1.6mΩ
$I_D$ (Silicon Limited)	380A ⑧
$I_D$ (Package Limited)	180A



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, $V_{GS}$ @ 10V (Silicon Limited)	380 ⑧	A
$I_D$ @ $T_c = 100^\circ\text{C}$	Continuous Drain Current, $V_{GS}$ @ 10V (Silicon Limited)	270 ⑧	
$I_D$ @ $T_c = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS}$ @ 10V (Package Limited)	180	
$I_{DM}$	Pulsed Drain Current ①	1580	
$P_D$ @ $T_c = 25^\circ\text{C}$	Power Dissipation	380	W
	Linear Derating Factor	2.5	W/°C
$V_{GS}$	Gate-to-Source Voltage	± 20	V
$E_{AS}$	Single Pulse Avalanche Energy (Thermally limited) ②	400	mJ
$E_{AS}$ (Tested)	Single Pulse Avalanche Energy Tested Value ⑧	1011	
$I_{AR}$	Avalanche Current ①	See Fig.17a, 17b, 14, 15	A
$E_{AR}$	Repetitive Avalanche Energy ⑤		mJ
$T_J$	Operating Junction and	-55 to + 175	°C
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 seconds		
	Mounting Torque, 6-32 or M3 screw	10 lbf·in (1.1N·m)	

## Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ②	—	0.40	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount, steady state) ⑦	—	40	

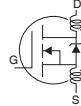
HEXFET® is a registered trademark of International Rectifier.

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

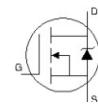
Static Electrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(\text{BR})\text{DSS}}$	Drain-to-Source Breakdown Voltage	24	—	—	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	—	0.02	—	V/ $^\circ\text{C}$	Reference to $25^\circ\text{C}$ , $I_D = 1\text{mA}$
$R_{\text{DS}(\text{on})}$	Static Drain-to-Source On-Resistance	—	1.25	1.6	$\text{m}\Omega$	$V_{\text{GS}} = 10\text{V}$ , $I_D = 180\text{A}$ ③
$V_{\text{GS}(\text{th})}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{\text{DS}} = V_{\text{GS}}$ , $I_D = 250\mu\text{A}$
$g_{\text{fs}}$	Forward Transconductance	230	—	—	S	$V_{\text{DS}} = 10\text{V}$ , $I_D = 180\text{A}$
$I_{\text{DSS}}$	Drain-to-Source Leakage Current	—	—	20	$\mu\text{A}$	$V_{\text{DS}} = 24\text{V}$ , $V_{\text{GS}} = 0\text{V}$
		—	—	250		$V_{\text{DS}} = 24\text{V}$ , $V_{\text{GS}} = 0\text{V}$ , $T_J = 125^\circ\text{C}$
$I_{\text{GSS}}$	Gate-to-Source Forward Leakage	—	—	200	nA	$V_{\text{GS}} = 20\text{V}$
	Gate-to-Source Reverse Leakage	—	—	-200		$V_{\text{GS}} = -20\text{V}$

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

$Q_g$	Total Gate Charge	—	260	390	nC	$I_D = 180\text{A}$
$Q_{\text{gs}}$	Gate-to-Source Charge	—	72	—		$V_{\text{DS}} = 12\text{V}$
$Q_{\text{gd}}$	Gate-to-Drain ("Miller") Charge	—	100	—		$V_{\text{GS}} = 10\text{V}$ ③
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	—	70	—	ns	$V_{\text{DD}} = 12\text{V}$
$t_r$	Rise Time	—	490	—		$I_D = 180\text{A}$
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time	—	150	—		$R_G = 2.5\ \Omega$
$t_f$	Fall Time	—	270	—	nH	$V_{\text{GS}} = 10\text{V}$ ③
$L_D$	Internal Drain Inductance	—	5.0	—		Between lead, 6mm (0.25in.) from package and center of die contact
$L_S$	Internal Source Inductance	—	13	—		
$C_{\text{iss}}$	Input Capacitance	—	11220	—	pF	$V_{\text{GS}} = 0\text{V}$
$C_{\text{oss}}$	Output Capacitance	—	4800	—		$V_{\text{DS}} = 25\text{V}$
$C_{\text{rss}}$	Reverse Transfer Capacitance	—	2660	—		$f = 1.0\text{KHz}$
$C_{\text{oss}}$	Output Capacitance	—	13020	—		$V_{\text{GS}} = 0\text{V}$ , $V_{\text{DS}} = 1.0\text{V}$ , $f = 1.0\text{KHz}$
$C_{\text{oss}}$	Output Capacitance	—	4800	—		$V_{\text{GS}} = 0\text{V}$ , $V_{\text{DS}} = 19\text{V}$ , $f = 1.0\text{KHz}$
$C_{\text{oss eff.}}$	Effective Output Capacitance	—	6710	—		$V_{\text{GS}} = 0\text{V}$ , $V_{\text{DS}} = 0\text{V}$ to $19\text{V}$ ④

## Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_s$	Continuous Source Current (Body Diode)	—	—	400 ⑧	A	MOSFET symbol showing the integral reverse p-n junction diode.
$I_{\text{SM}}$	Pulsed Source Current (Body Diode) ①	—	—	1580		
$V_{\text{SD}}$	Diode Forward Voltage	—	—	1.3		$T_J = 25^\circ\text{C}$ , $I_s = 180\text{A}$ , $V_{\text{GS}} = 0\text{V}$ ③
$t_{\text{rr}}$	Reverse Recovery Time	—	55	83	ns	$T_J = 25^\circ\text{C}$ , $I_F = 180\text{A}$ , $V_{\text{DD}} = 12\text{V}$
$Q_{\text{rr}}$	Reverse Recovery Charge	—	56	84	nC	$\text{di}/\text{dt} = 100\text{A}/\mu\text{s}$ ③
$t_{\text{on}}$	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. (See fig. 11).
- ② Limited by  $T_{\text{Jmax}}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.025\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{\text{AS}} = 180\text{A}$ ,  $V_{\text{GS}} = 10\text{V}$ . Part not recommended for use above this value.
- ③ Pulse width  $\leq 1.0\text{ms}$ ; duty cycle  $\leq 2\%$ .
- ④  $C_{\text{oss eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{\text{oss}}$  while  $V_{\text{DS}}$  is rising from 0 to 80%  $V_{\text{DSS}}$ .
- ⑤ Limited by  $T_{\text{Jmax}}$ , 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  $R_\theta$  is measured at  $T_J$  approximately  $90^\circ\text{C}$ .
- ⑧ Calculated continuous current based on maximum allowable junction temperature. Bond wire current limit is 180A. Note that current limitations arising from heating of the device leads may occur with some lead mounting arrangements.

<b>Qualification Information<sup>†</sup></b>		
<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>	3L-T0-247	N/A
<b>ESD</b>	Machine Model	Class M4(+/- 800V) <sup>†††</sup> (per AEC-Q101-002)
	Human Body Model	Class H2(+/- 4000V) <sup>†††</sup> (per AEC-Q101-001)
	Charged Device Model	Class C5(+/- 2000V) <sup>†††</sup> (per 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 (if any) to AEC-Q101 requirements are noted in the qualification report.

<sup>†††</sup> Highest passing voltage

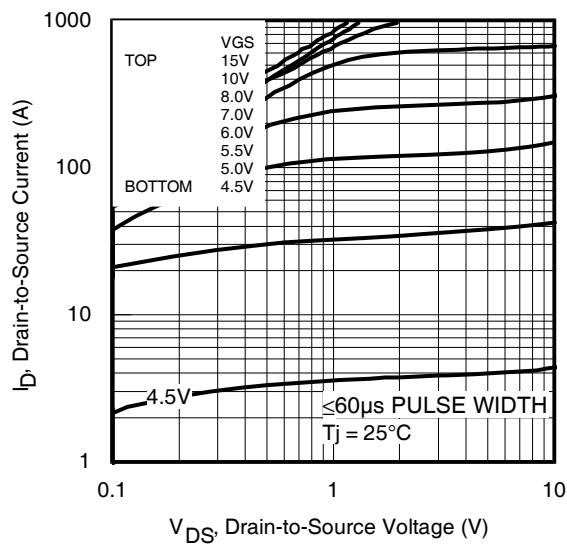


Fig 1. Typical Output Characteristics

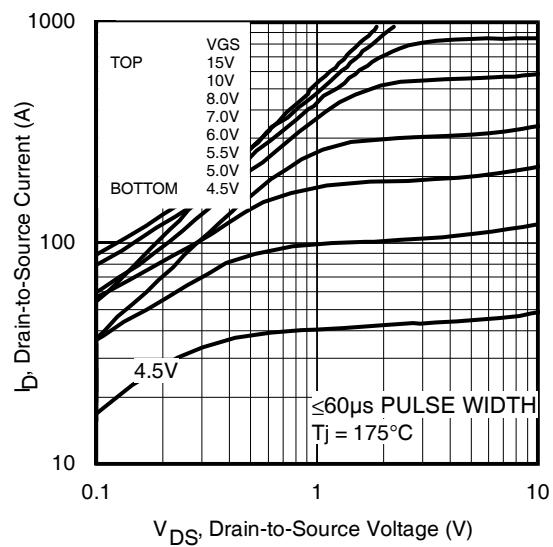


Fig 2. Typical Output Characteristics

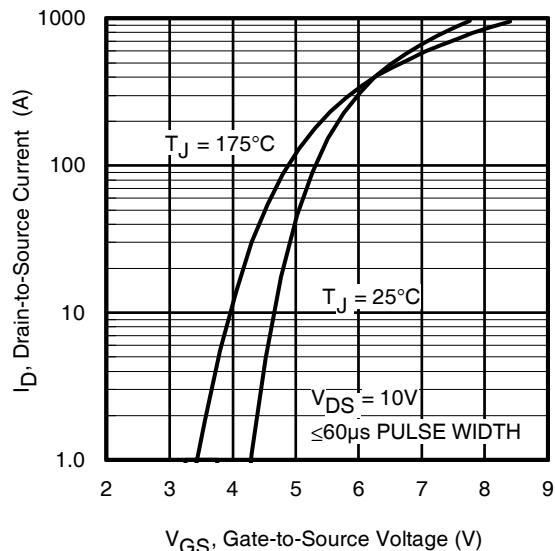


Fig 3. Typical Transfer Characteristics

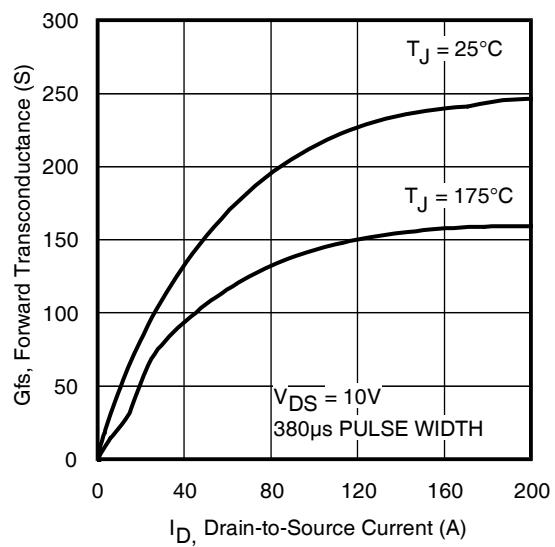


Fig 4. Typical Forward Transconductance vs. Drain Current

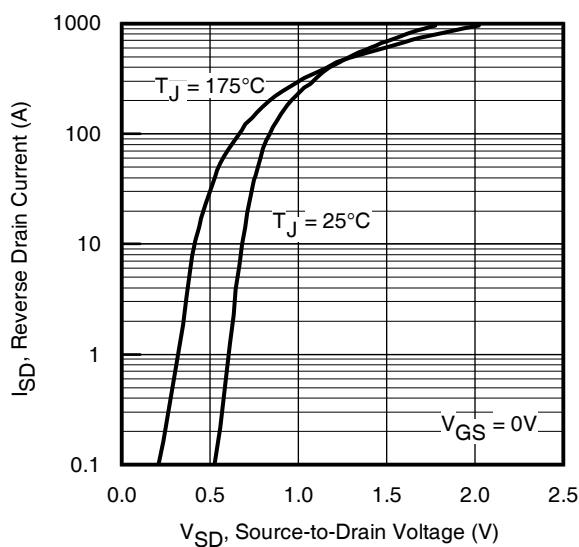


Fig 5. Typical Source-Drain Diode Forward Voltage

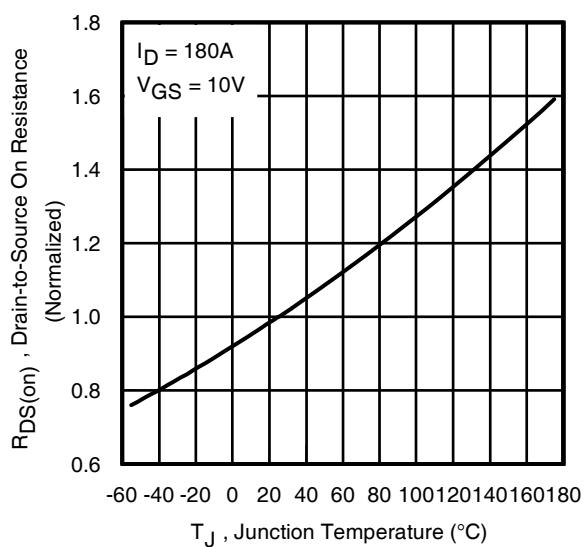


Fig 6. Normalized On-Resistance vs. Temperature

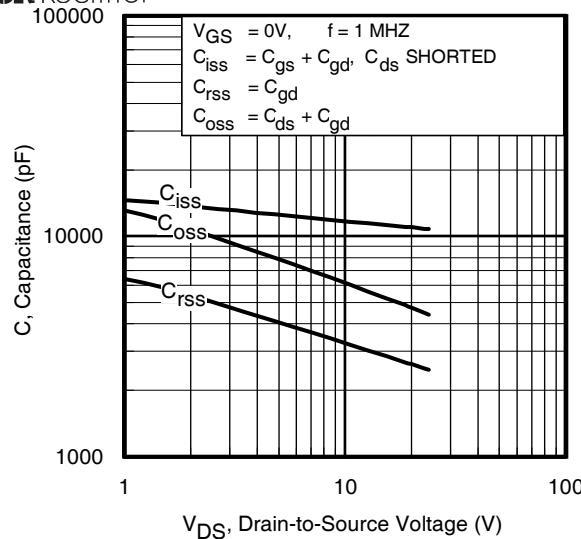


Fig 7. Typical Capacitance vs. Drain-to-Source Voltage

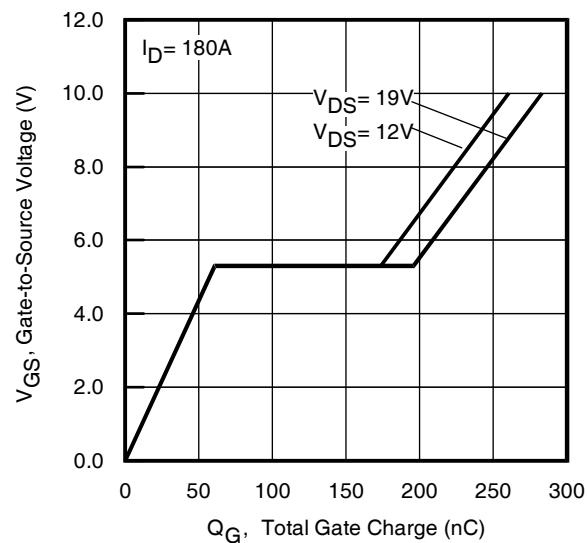


Fig 8. Typical Gate Charge vs. Gate-to-Source Voltage

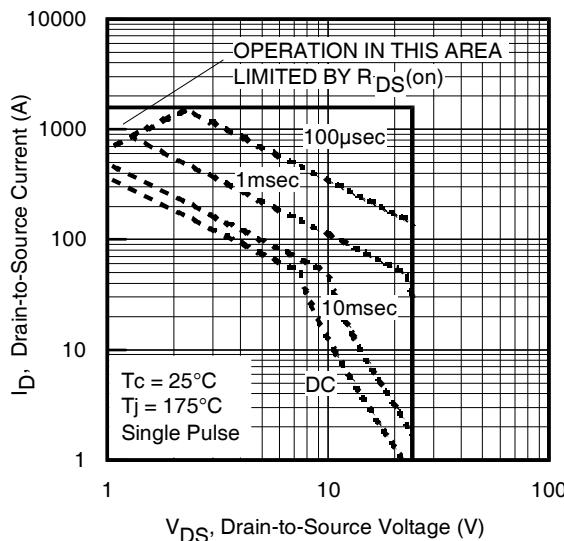


Fig 9. Maximum Safe Operating Area

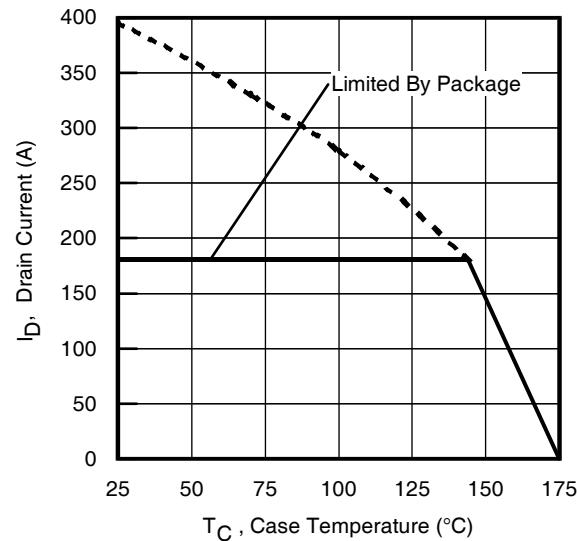


Fig 10. Maximum Drain Current vs. Case Temperature

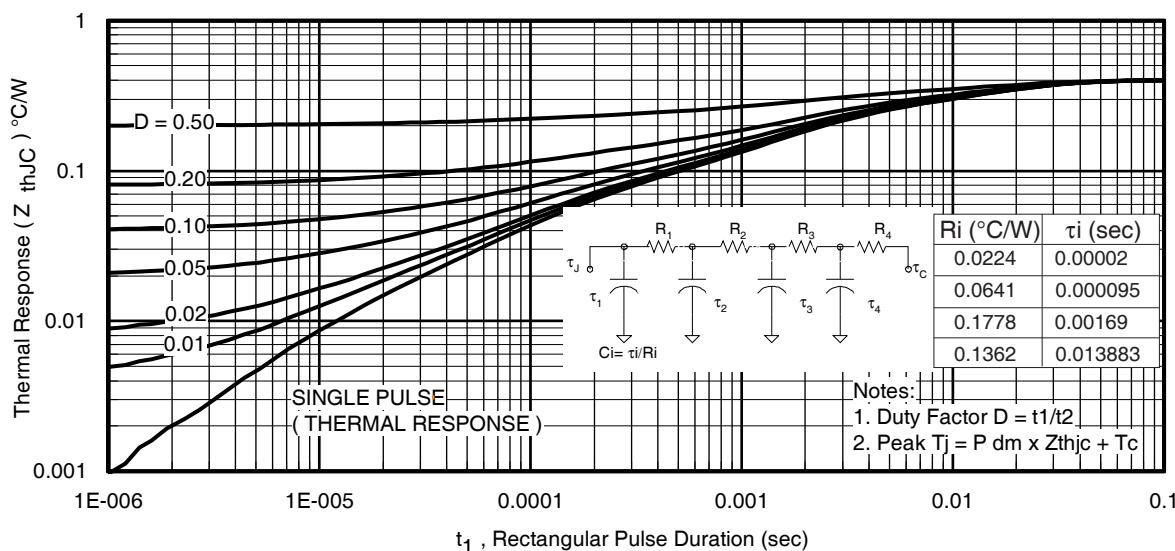


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

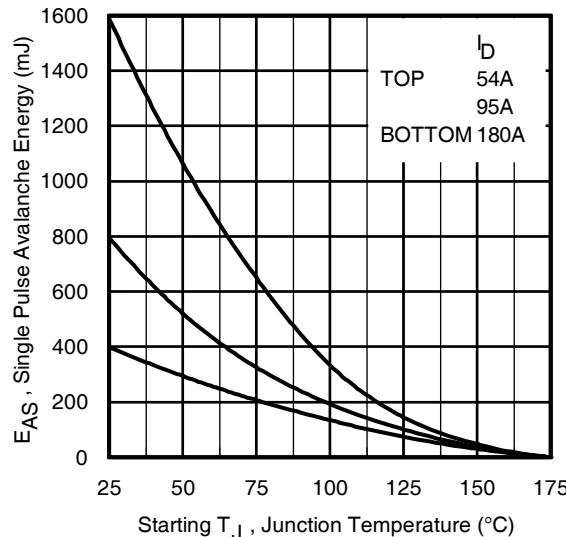


Fig 12. Maximum Avalanche Energy vs. Drain Current

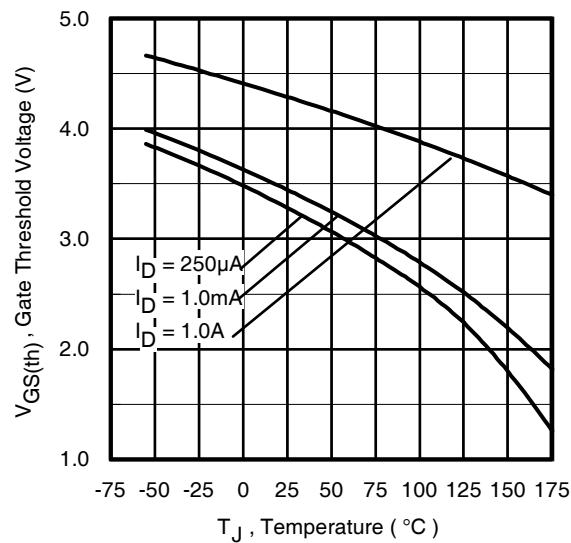


Fig 13. Threshold Voltage vs. Temperature

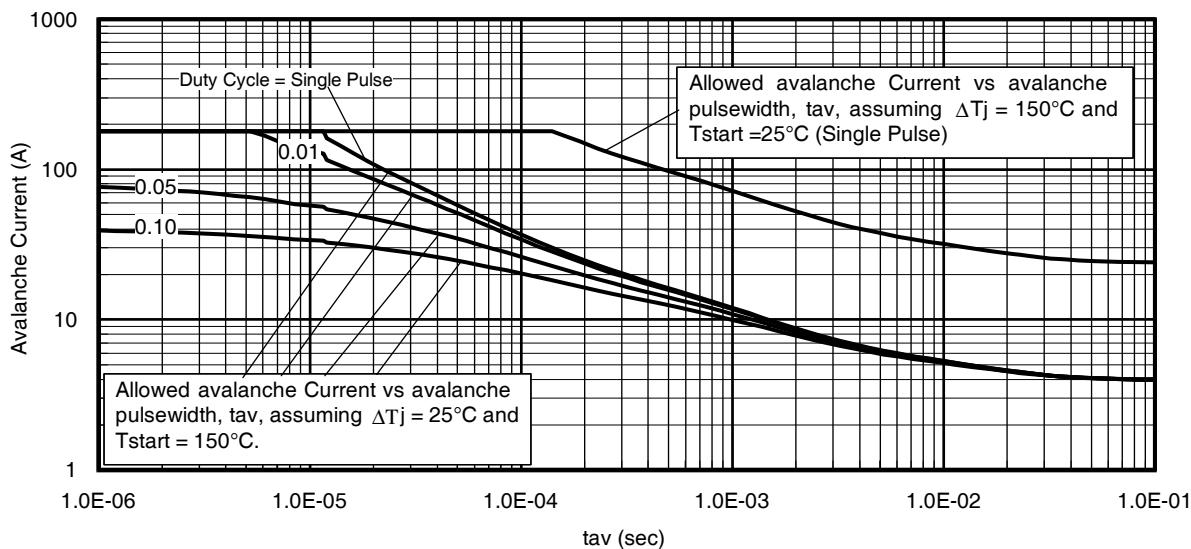


Fig 14. Typical Avalanche Current vs.Pulsewidth

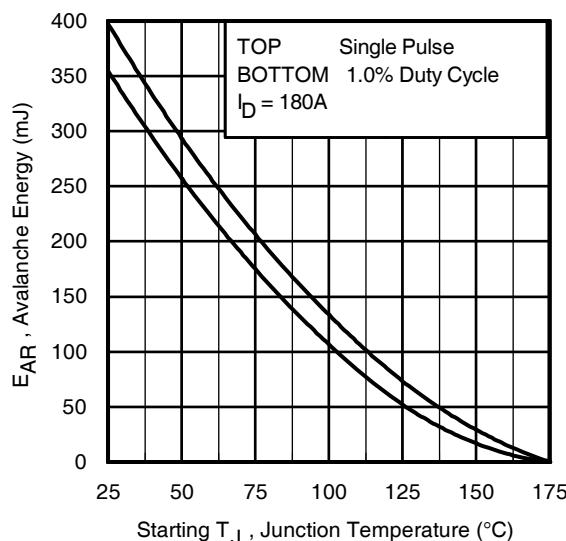


Fig 15. Maximum Avalanche Energy vs. Temperature

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

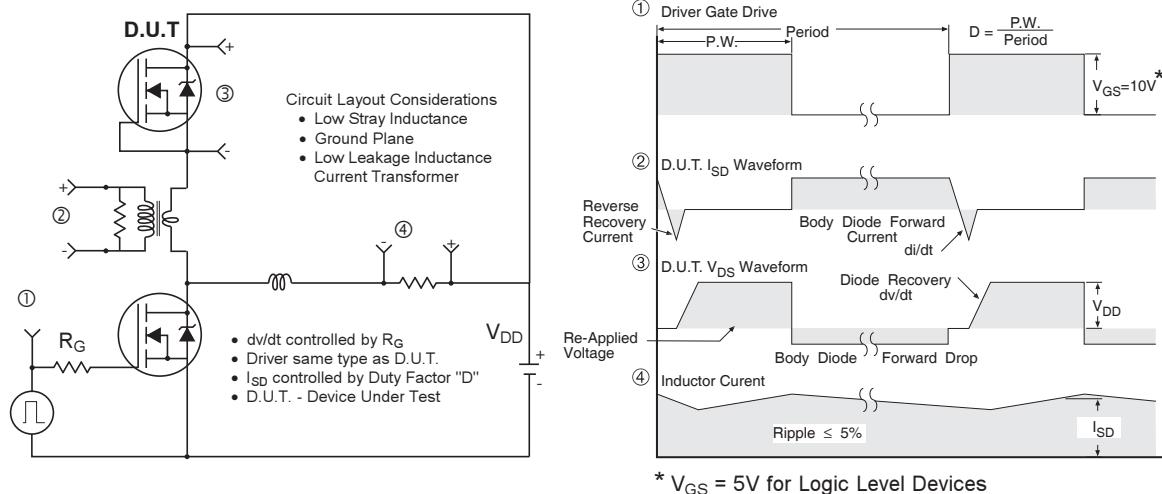
1. Avalanche failures assumption:  
Purely a thermal phenomenon and failure occurs at a temperature far in excess of  $T_{jmax}$ . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as  $T_{jmax}$  is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 17a, 17b.
4.  $P_D(\text{ave})$  = 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  $T_{jmax}$  (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 figure 11)

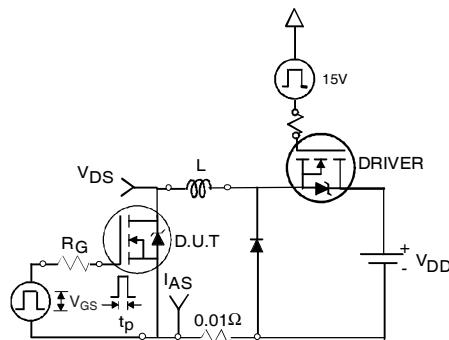
$$P_D(\text{ave}) = 1/2 ( 1.3 \cdot BV \cdot I_{av} ) = \Delta T / Z_{thJC}$$

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

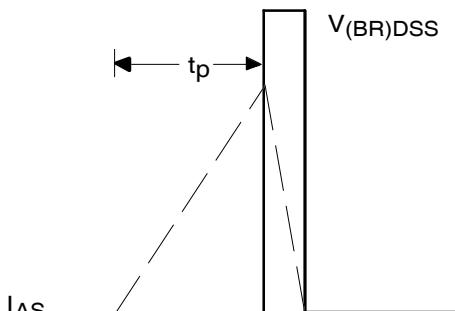
$$E_{AS}(\text{AR}) = P_D(\text{ave}) \cdot t_{av}$$



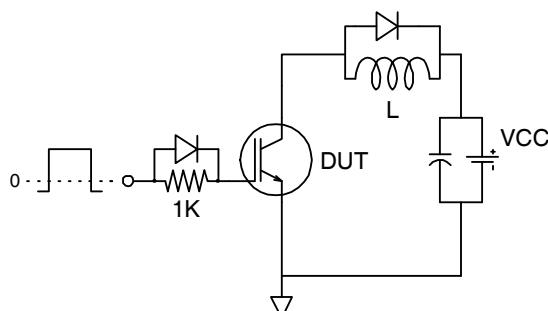
**Fig 16.** Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs



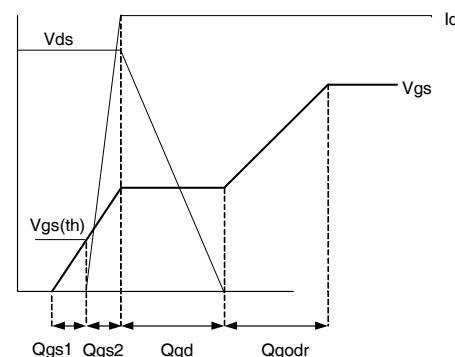
**Fig 17a.** Unclamped Inductive Test Circuit



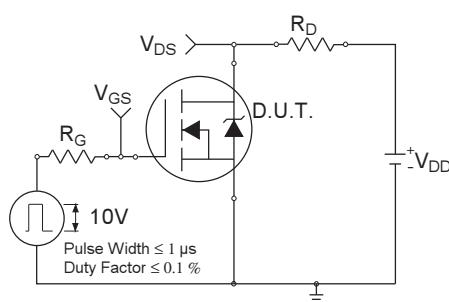
**Fig 17b.** Unclamped Inductive Waveforms



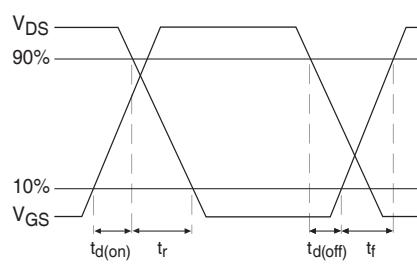
**Fig 18a.** Gate Charge Test Circuit



**Fig 18b.** Gate Charge Waveform



**Fig 19a.** Switching Time Test Circuit



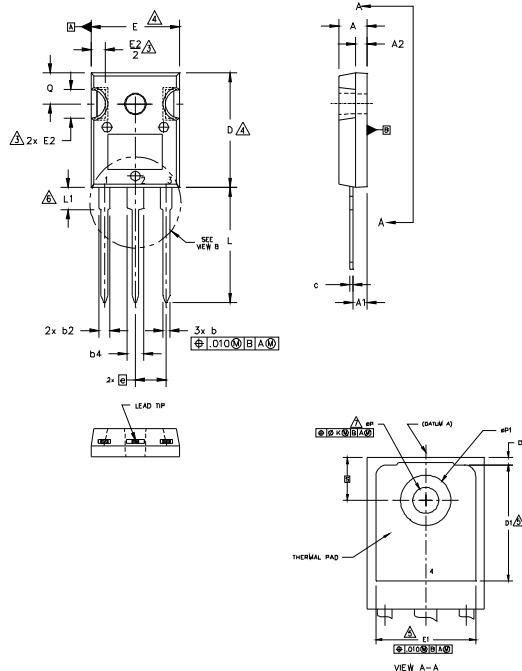
**Fig 19b.** Switching Time Waveforms

AUIRFP2602

International  
**IR** Rectifier

## TO-247AD Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES.
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  $1.5^\circ$  TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF  $.154$  INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AD.

SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.183	.209	4.65	5.31	
A1	.087	.102	2.21	2.59	
A2	.059	.098	1.50	2.49	
b	.039	.045	0.99	1.40	
b1	.039	.063	0.99	1.35	
b2	.065	.094	1.65	2.39	
b3	.065	.092	1.65	2.34	
b4	.102	.135	2.59	3.43	
b5	.102	.133	2.59	3.38	
c	.015	.035	0.38	0.89	
c1	.015	.033	0.38	0.84	
D	.776	.815	19.77	20.70	4
DI	.515	—	13.08	—	5
D2	.020	.053	0.51	1.35	
E	.602	.625	15.29	15.87	4
E1	.530	—	13.46	—	
E2	.178	.216	4.52	5.49	
e	.215 BSC		5.46 BSC		
øk	.010		0.25		
L	.780	.827	19.57	21.00	
L1	.146	.169	3.71	4.29	
øP	.140	.144	3.56	3.66	
øP1	—	.291	—	7.39	
Q	.209	.224	5.31	5.69	
S	.217 BSC		5.51 BSC		

## LEAD ASSIGNMENTS

## HEXFET

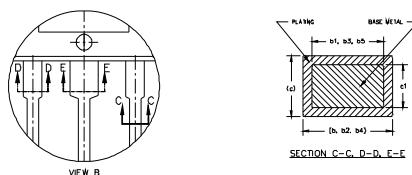
1. - GATE
2. - DRAIN
3. - SOURCE
- 4 - DRAIN

IGBTs CoPACK

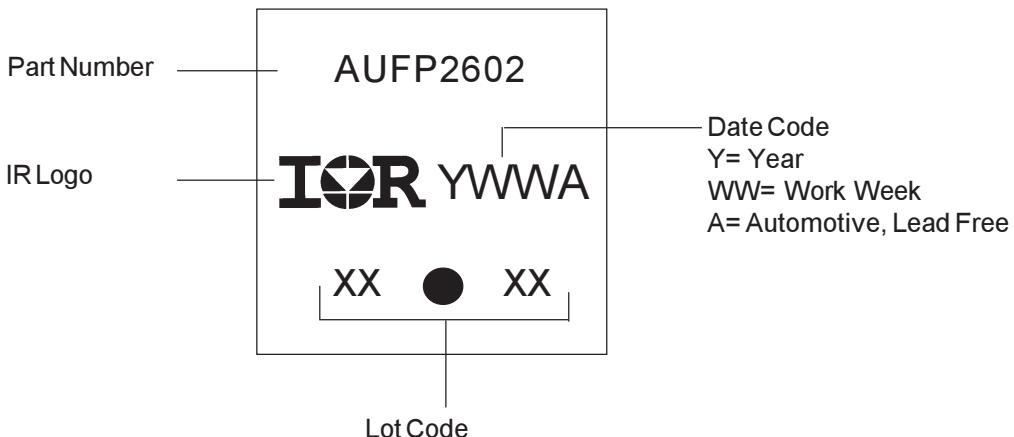
- 1. - GATE
- 2. - COLLECTOR
- 3. - Emitter
- 4. - COLLECTOR

DIODES

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



## TO-247AD Part Marking Information



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

**Ordering Information**

<b>Base part</b>	<b>Package Type</b>	<b>Standard Pack</b>		<b>Complete Part Number</b>
		<b>Form</b>	<b>Quantity</b>	
AUIRFP2602	TO-247	Tube	25	AUIRFP2602

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

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