International
IOR Rectifier

AUTOMOTIVE GRADE

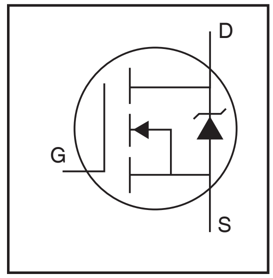
PD - 96420

AUIRFP2602

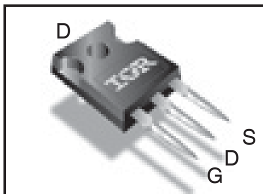
HEXFET® Power MOSFET

Features

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



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



TO-247AD

G	D	S
Gate	Drain	Source

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.

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°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)	380 ⑧	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)	270 ⑧	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Package Limited)	180	
I_{DM}	Pulsed Drain Current ①	1580	
P_D @T_C = 25°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 ⑥	1011	
I_{AR}	Avalanche Current ①	See Fig.17a, 17b, 14, 15	A
E_{AR}	Repetitive Avalanche Energy ⑤		mJ
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C
	Soldering Temperature, for 10 seconds	300 (1.6mm from case)	
	Mounting Torque, 6-32 or M3 screw	10 lbf•in (1.1N•m)	

Thermal Resistance

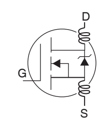
	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ⑦	—	0.40	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount, steady state) ⑦	—	40	

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

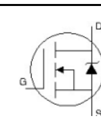
Static Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

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

Dynamic Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

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

Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	–––	–––	400 ⑧	A	MOSFET symbol showing the
I_{SM}	Pulsed Source Current (Body Diode) ①	–––	–––	1580		integral reverse p-n junction diode. 
V_{SD}	Diode Forward Voltage	–––	–––	1.3	V	T_J = 25°C, I_S = 180A, V_{GS} = 0V ③
t_{rr}	Reverse Recovery Time	–––	55	83	ns	T_J = 25°C, I_F = 180A, V_{DD} = 12V
Q_{rr}	Reverse Recovery Charge	–––	56	84	nC	di/dt = 100A/µs ③
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. (See fig. 11).

② Limited by T_{Jmax}, starting T_J = 25°C, L = 0.025mH, R_G = 25Ω, I_{AS} = 180A, V_{GS} =10V. Part not recommended for use above this value.

③ Pulse width ≤ 1.0ms; duty cycle ≤ 2%.

④ C_{oss} eff. is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

⑤ Limited by T_{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_θ is measured at T_J approximately 90°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.

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-TO-247	N/A
ESD	Machine Model	Class M4(+/- 800V)††† (per AEC-Q101-002)	
	Human Body Model	Class H2(+/- 4000V)††† (per AEC-Q101-001)	
	Charged Device Model	Class C5(+/- 2000V)††† (per 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

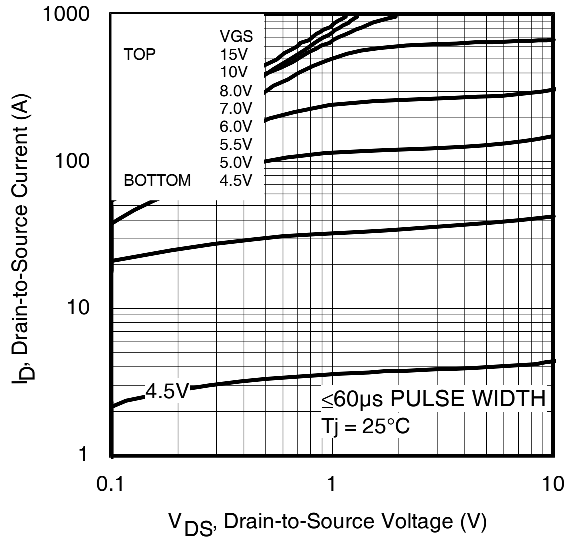


Fig 1. Typical Output Characteristics

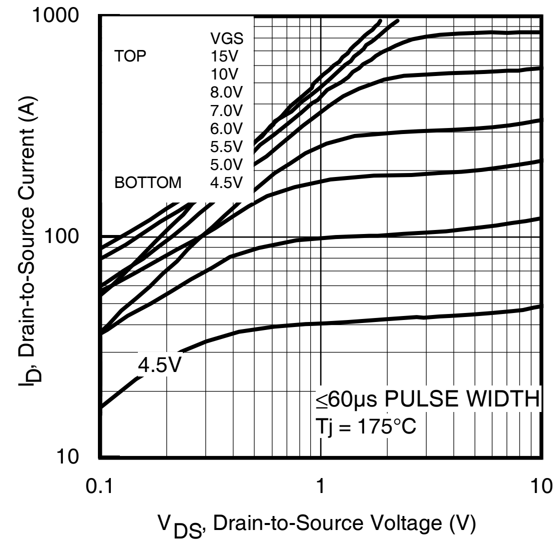


Fig 2. Typical Output Characteristics

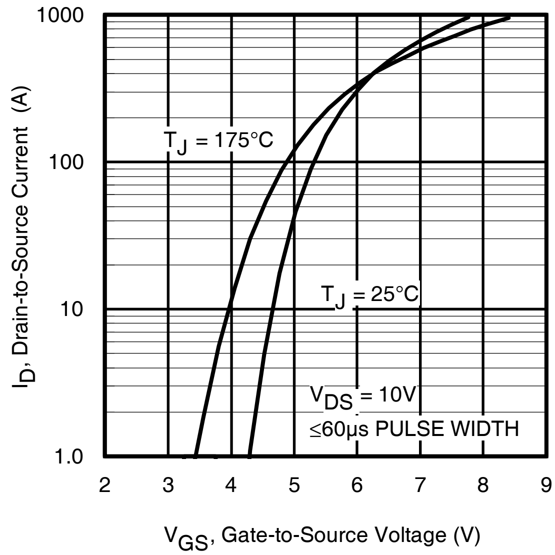


Fig 3. Typical Transfer Characteristics

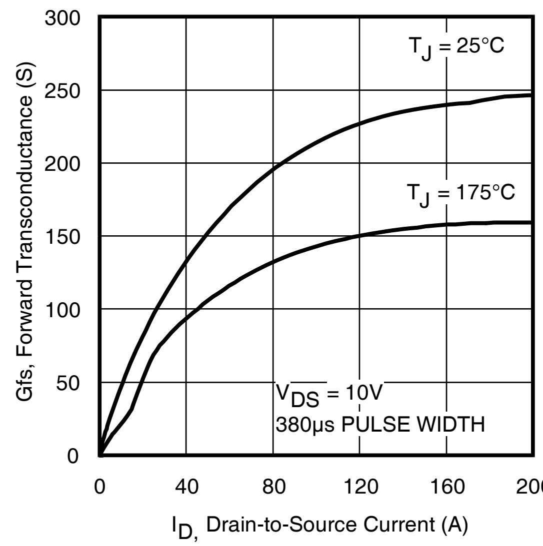


Fig 4. Typical Forward Transconductance vs. Drain Current

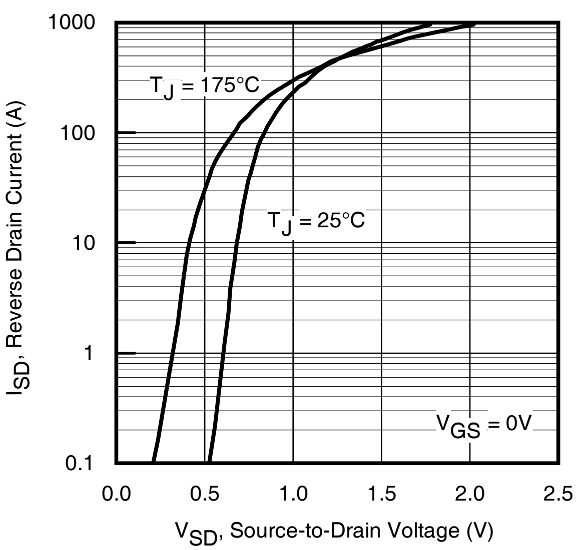


Fig 5. Typical Source-Drain Diode Forward Voltage

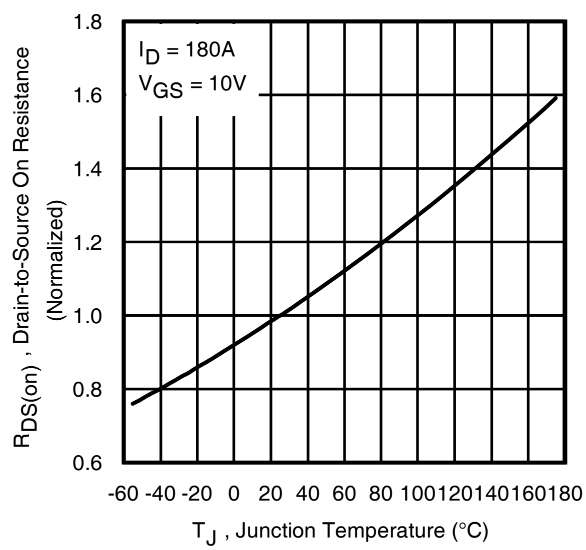


Fig 6. Normalized On-Resistance vs. Temperature

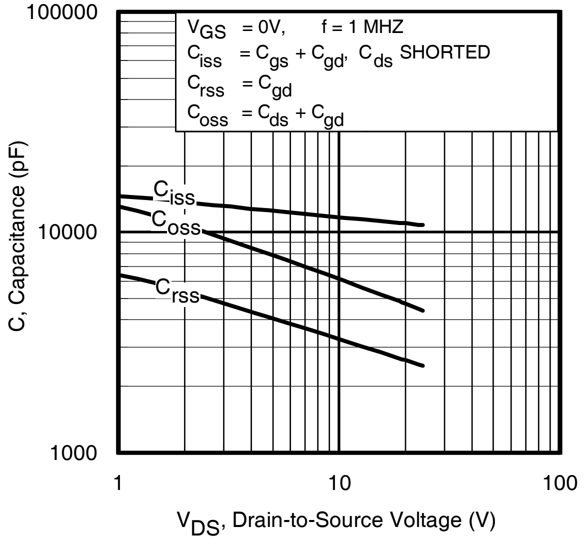


Fig 7. Typical Capacitance vs. Drain-to-Source Voltage

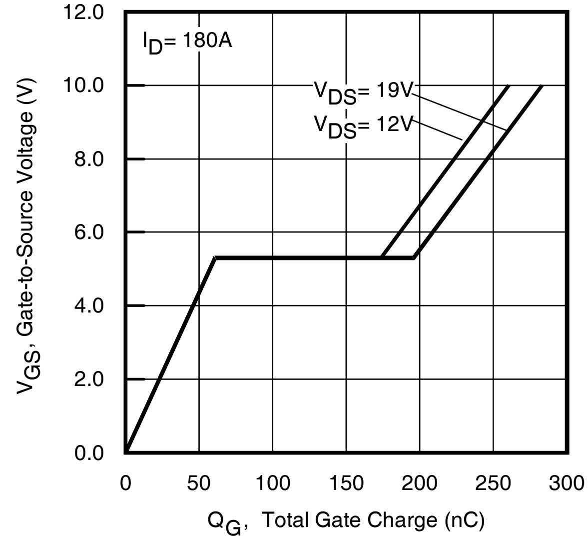


Fig 8. Typical Gate Charge vs. Gate-to-Source Voltage

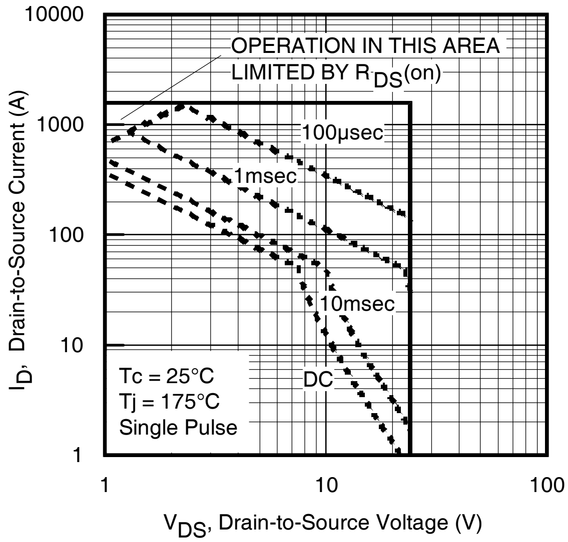


Fig 9. Maximum Safe Operating Area

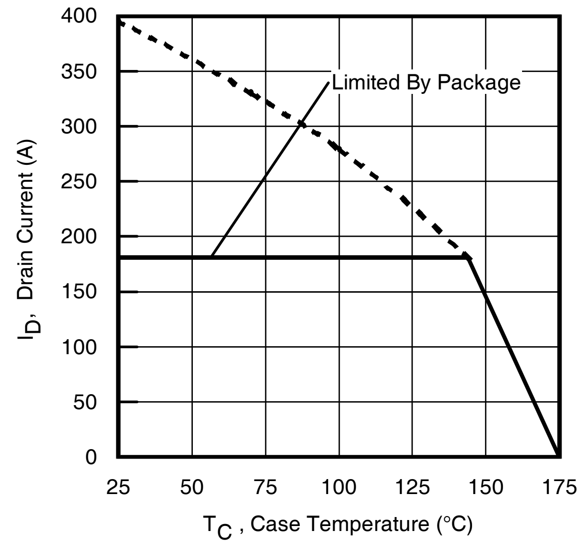


Fig 10. Maximum Drain Current vs. Case Temperature

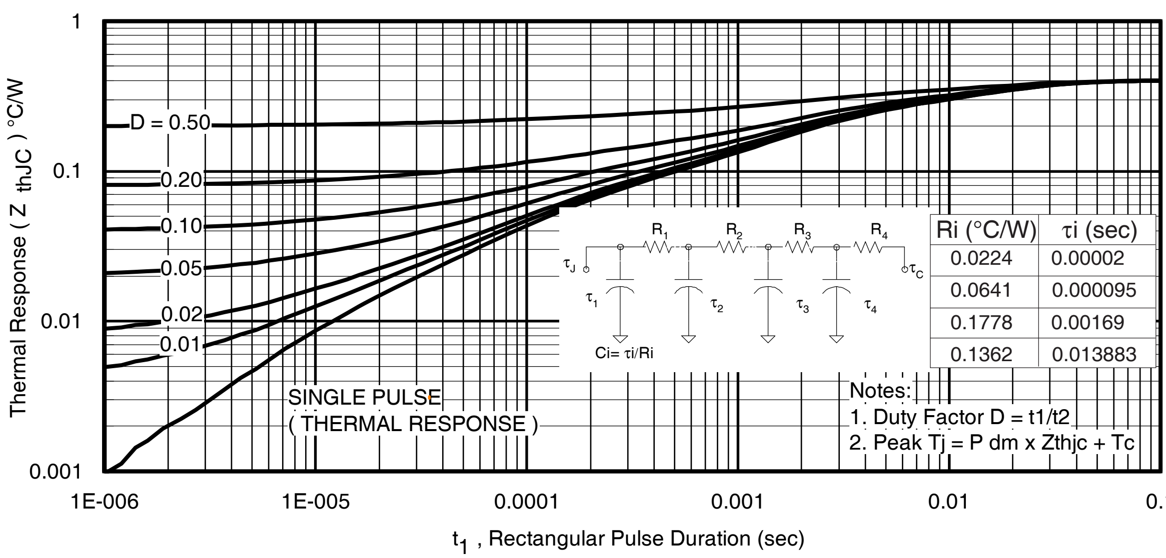


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

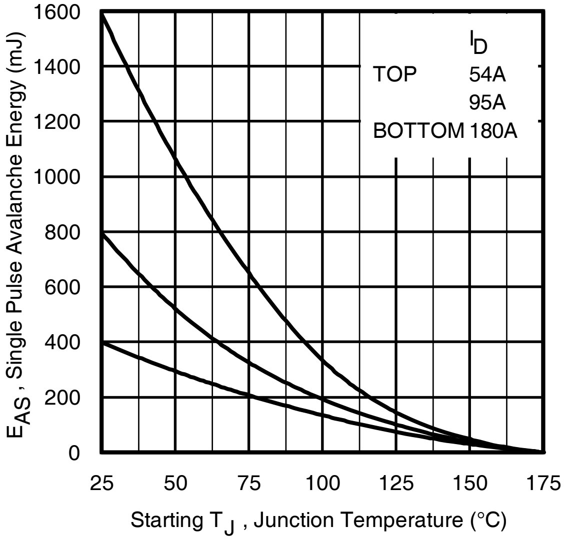


Fig 12. Maximum Avalanche Energy vs. Drain Current

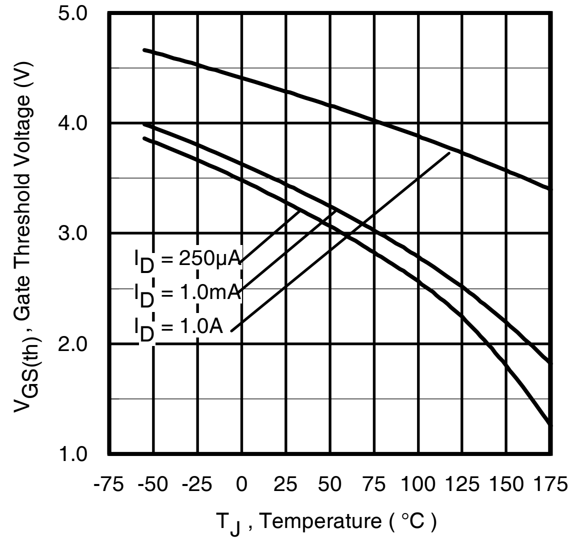


Fig 13. Threshold Voltage vs. Temperature

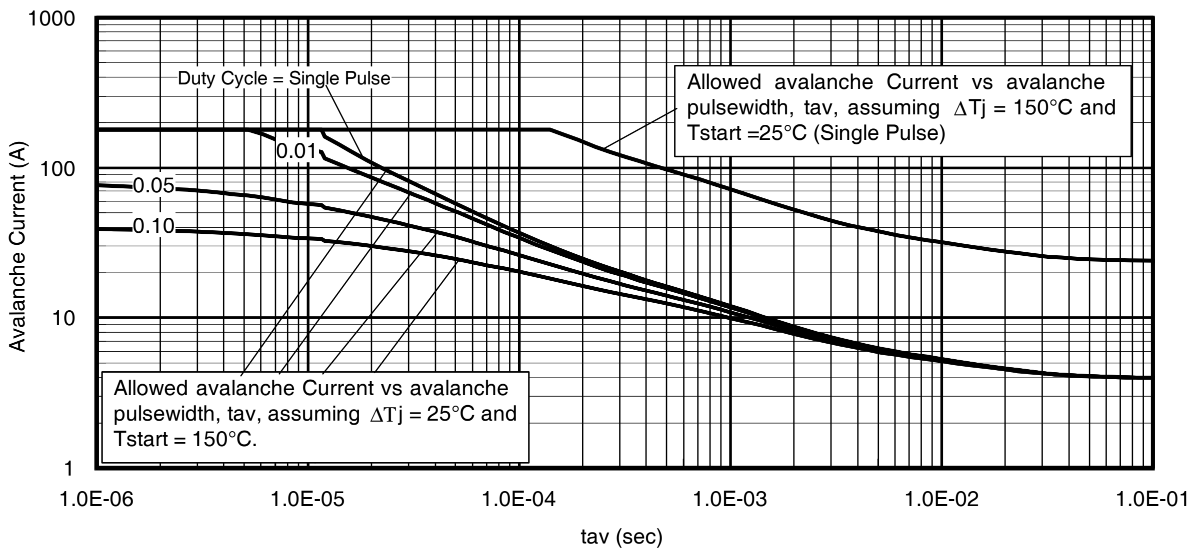


Fig 14. Typical Avalanche Current vs.Pulsewidth

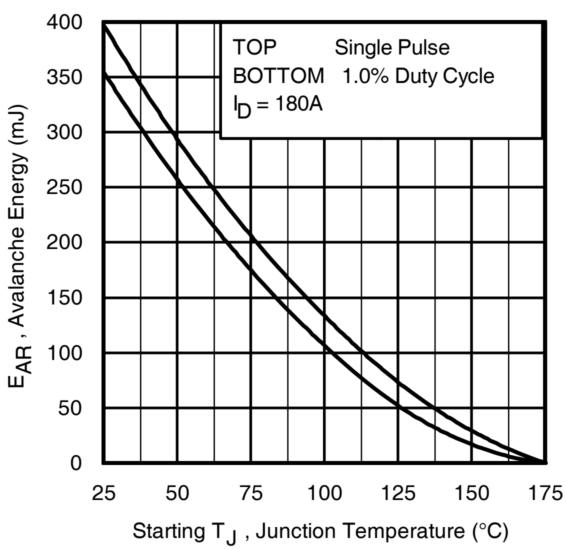


Fig 15. Maximum Avalanche Energy vs. Temperature

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

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 asT_{jmax} is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 17a, 17b.
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 figure 11)

$$\mathbf{P_{D\ (ave)} = 1/2\ (\ 1.3 \cdot BV \cdot I_{av}) = \Delta T /\ Z_{thJC}}$$
$$\mathbf{I_{av} = 2\Delta T /\ [1.3 \cdot BV \cdot Z_{th}]}$$
$$\mathbf{E_{AS\ (AR)} = P_{D\ (ave)} \cdot t_{av}}$$

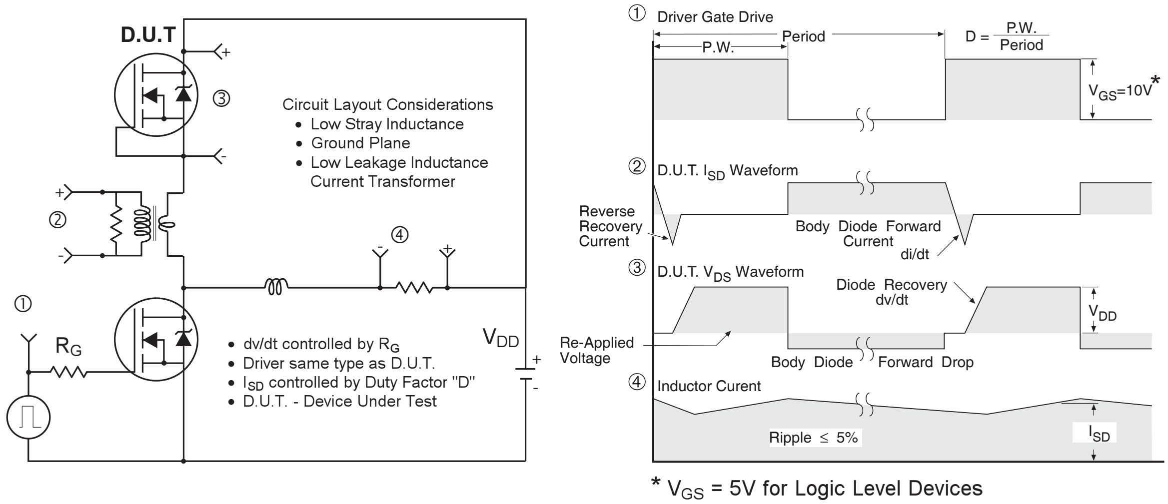


Fig 16. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

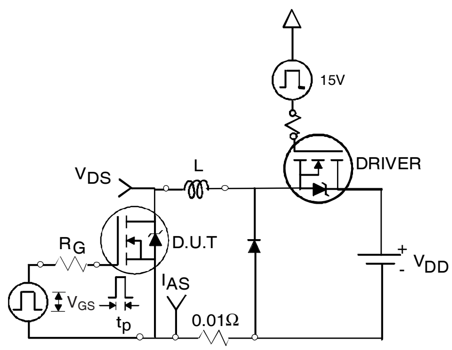


Fig 17a. Unclamped Inductive Test Circuit

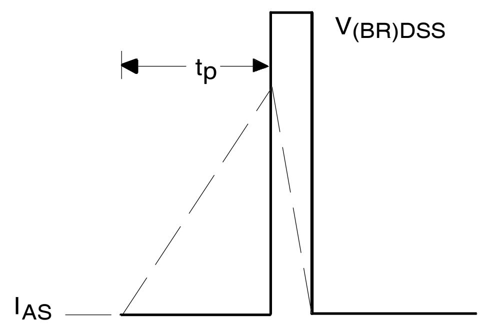


Fig 17b. Unclamped Inductive Waveforms

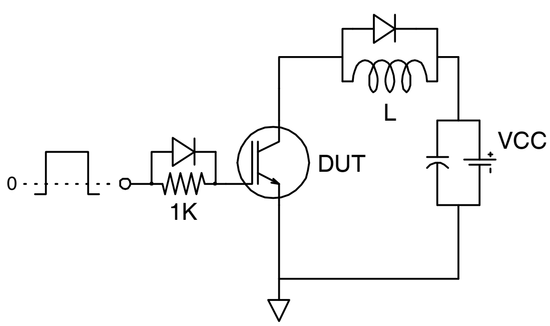


Fig 18a. Gate Charge Test Circuit

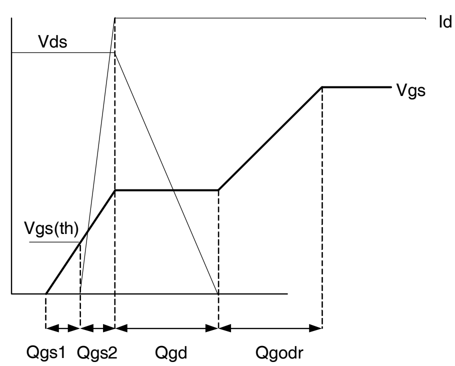


Fig 18b. Gate Charge Waveform

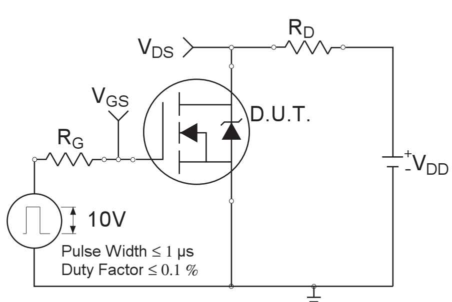


Fig 19a. Switching Time Test Circuit

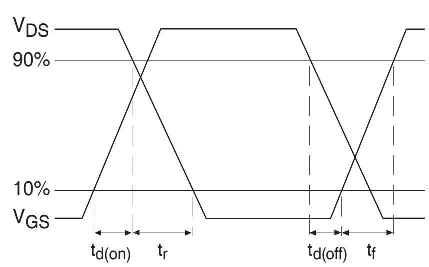
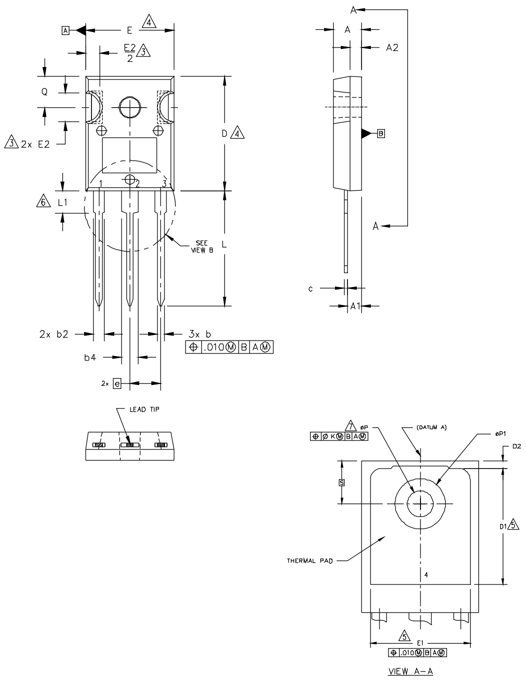


Fig 19b. Switching Time Waveforms

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. øP TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° 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	.055	0.99	1.40	
b1	.039	.053	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	19.71	20.70	4
D1	.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

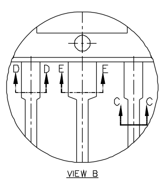
1.- GATE
2.- DRAIN
3.- SOURCE
4.- DRAIN

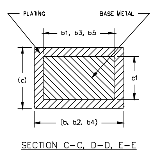
IGBTs, CoPACK

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

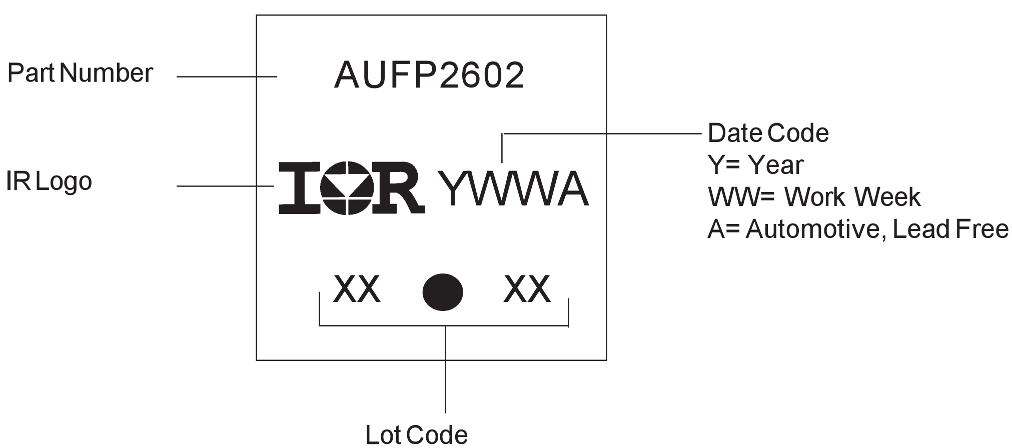
DIODES

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

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

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