

## REPETITIVE AVALANCHE AND $dv/dt$ RATED HEXFET<sup>®</sup> TRANSISTORS THRU-HOLE (TO-204AA/AE)

## IRF440 500V, N-CHANNEL

### Product Summary

Part Number	BVDSS	RDS(on)	ID
IRF440	500V	0.85Ω	8.0A

The HEXFET<sup>®</sup> technology is the key to International Rectifier's advanced line of power MOSFET transistors. The efficient geometry and unique processing of this latest "State of the Art" design achieves: very low on-state resistance combined with high transconductance; superior reverse energy and diode recovery  $dv/dt$  capability.

The HEXFET transistors also feature all of the well established advantages of MOSFETs such as voltage control, very fast switching, ease of paralleling and temperature stability of the electrical parameters.

They are well suited for applications such as switching power supplies, motor controls, inverters, choppers, audio amplifiers and high energy pulse circuits.



### Features:

- Repetitive Avalanche Ratings
- Dynamic  $dv/dt$  Rating
- Hermetically Sealed
- Simple Drive Requirements
- Ease of Paralleling

### Absolute Maximum Ratings

	Parameter		Units
$I_D$ @ $V_{GS} = 0V, T_C = 25^\circ C$	Continuous Drain Current	8.0	A
$I_D$ @ $V_{GS} = 0V, T_C = 100^\circ C$	Continuous Drain Current	5.0	
$I_{DM}$	Pulsed Drain Current ①	32	
$P_D$ @ $T_C = 25^\circ C$	Max. Power Dissipation	125	W
	Linear Derating Factor	1.0	W/ $^\circ C$
$V_{GS}$	Gate-to-Source Voltage	$\pm 20$	V
EAS	Single Pulse Avalanche Energy ②	700	mJ
$I_{AR}$	Avalanche Current ①	8.0	A
EAR	Repetitive Avalanche Energy ①	-	mJ
$dv/dt$	Peak Diode Recovery $dv/dt$ ③	3.5	V/ns
$T_J$	Operating Junction	-55 to 150	$^\circ C$
$T_{STG}$	Storage Temperature Range		
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)	
	Weight	11.5 (typical)	g

For footnotes refer to the last page

**Electrical Characteristics @ T<sub>j</sub> = 25°C (Unless Otherwise Specified)**

	Parameter	Min	Typ	Max	Units	Test Conditions
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	500	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	Temperature Coefficient of Breakdown Voltage	—	0.78	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.85	Ω	V <sub>GS</sub> = 10V, I <sub>D</sub> = 5.0A <sup>④</sup>
		—	—	0.98		V <sub>GS</sub> = 10V, I <sub>D</sub> = 8.0A <sup>④</sup>
V <sub>GS(th)</sub>	Gate Threshold Voltage	2.0	—	4.0	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA
g <sub>fs</sub>	Forward Transconductance	4.7	—	—	S (S)	V <sub>DS</sub> > 15V, I <sub>DS</sub> = 5.0A <sup>④</sup>
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	25	μA	V <sub>DS</sub> = 400V, V <sub>GS</sub> = 0V
		—	—	250		V <sub>DS</sub> = 400V V <sub>GS</sub> = 0V, T <sub>J</sub> = 125°C
I <sub>GSS</sub>	Gate-to-Source Leakage Forward	—	—	100	nA	V <sub>GS</sub> = 20V
I <sub>GSS</sub>	Gate-to-Source Leakage Reverse	—	—	-100		V <sub>GS</sub> = -20V
Q <sub>g</sub>	Total Gate Charge	27.3	—	68.5	nC	V <sub>GS</sub> = 10V, I <sub>D</sub> = 8.0A V <sub>DS</sub> = 250V
Q <sub>gs</sub>	Gate-to-Source Charge	2.0	—	12.5		
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	11	—	42		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	21	ns	V <sub>DD</sub> = 250V, I <sub>D</sub> = 8.0A, R <sub>G</sub> = 9.1Ω
t <sub>r</sub>	Rise Time	—	—	73		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	72		
t <sub>f</sub>	Fall Time	—	—	51		
L <sub>S</sub> + L <sub>D</sub>	Total Inductance	—	6.1	—	nH	Measured from drain lead (6mm/0.25in. from package) to source lead (6mm/0.25in. from package)
C <sub>iss</sub>	Input Capacitance	—	1300	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	310	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	120	—		

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	8.0	A	
I <sub>SM</sub>	Pulse Source Current (Body Diode) <sup>①</sup>	—	—	32		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.5	V	T <sub>J</sub> = 25°C, I <sub>S</sub> = 8.0A, V <sub>GS</sub> = 0V <sup>④</sup>
t <sub>rr</sub>	Reverse Recovery Time	—	—	700	rS	T <sub>J</sub> = 25°C, I <sub>F</sub> = 8.0A, di/dt ≤ 100A/μs
Q <sub>R</sub>	Reverse Recovery Charge	—	—	8.9	μC	V <sub>DD</sub> ≤ 50V <sup>④</sup>
t <sub>on</sub>	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L <sub>S</sub> + L <sub>D</sub> .				

**Thermal Resistance**

	Parameter	Min	Typ	Max	Units	Test Conditions
R <sub>thJC</sub>	Junction to Case	—	—	1.0	°C/W	Typical socket mount
R <sub>thJA</sub>	Junction to Ambient	—	—	30		

For footnotes refer to the last page

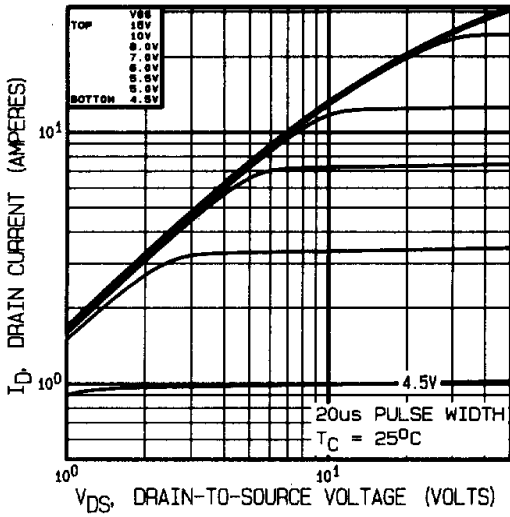


Fig 1. Typical Output Characteristics

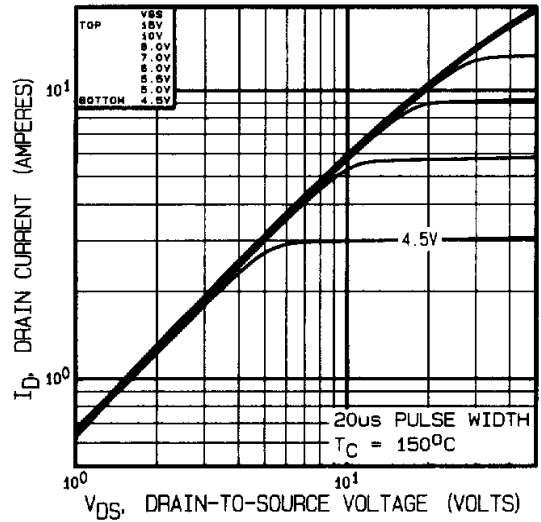


Fig 2. Typical Output Characteristics

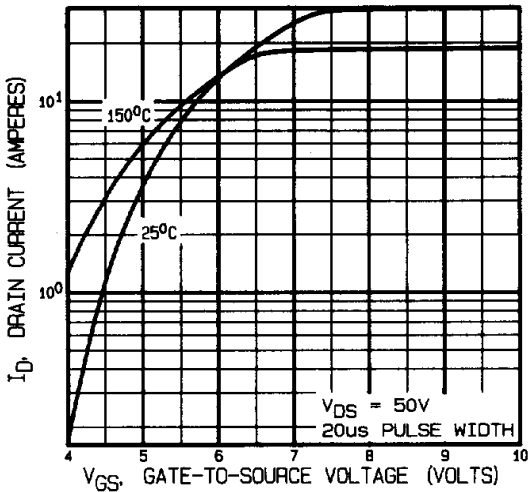


Fig 3. Typical Transfer Characteristics

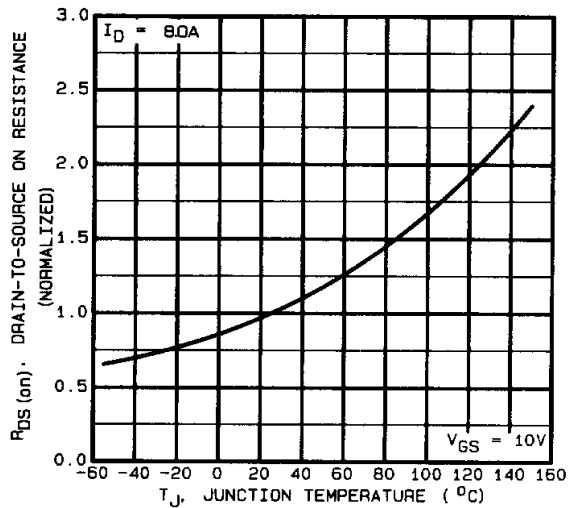
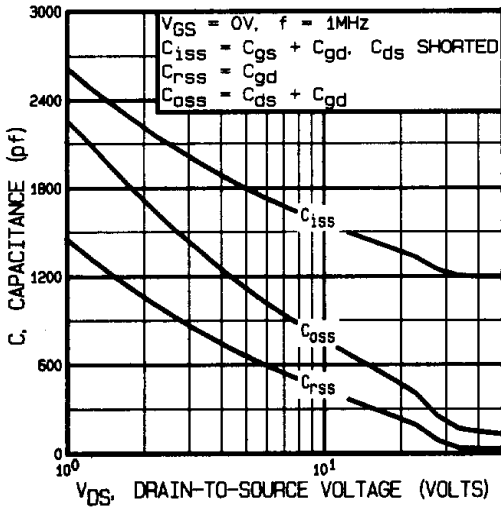
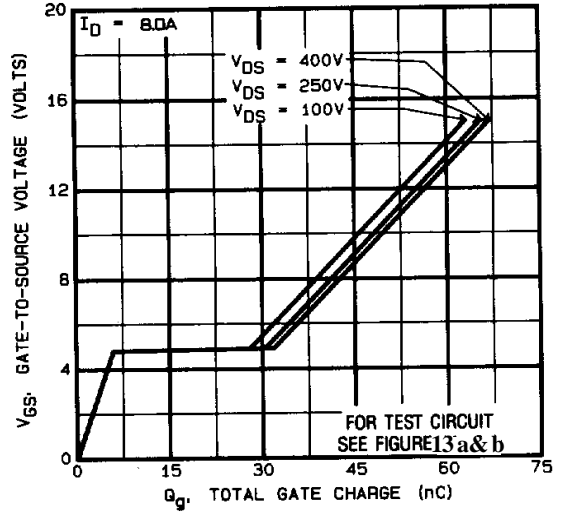


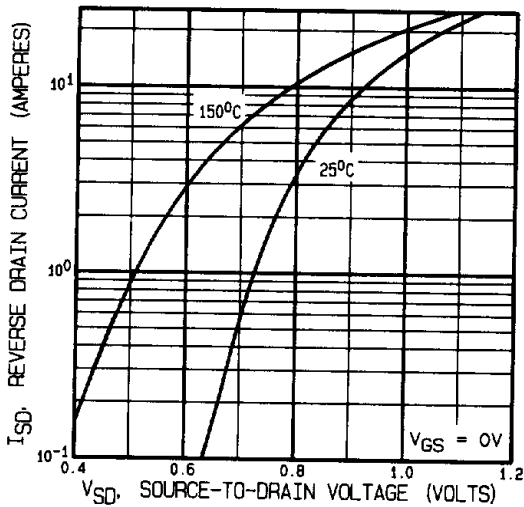
Fig 4. Normalized On-Resistance Vs. Temperature



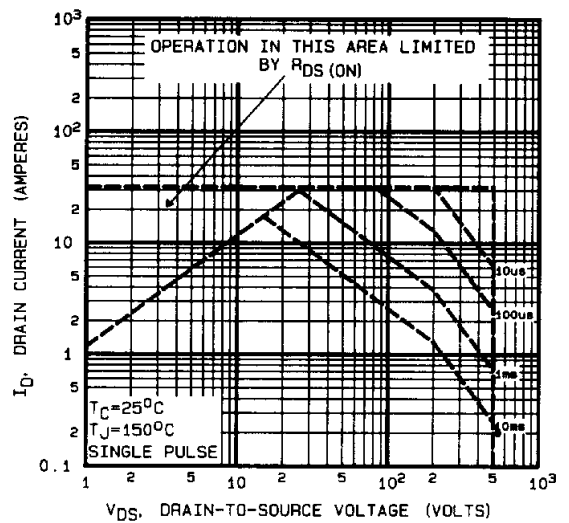
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



**Fig 7.** Typical Source-Drain Diode Forward Voltage



**Fig 8.** Maximum Safe Operating Area

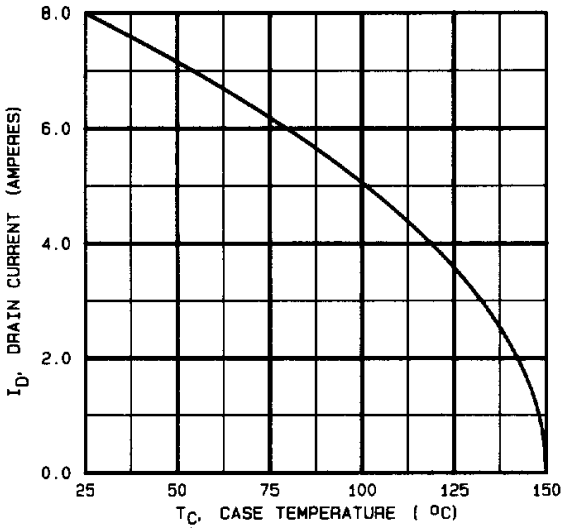


Fig 9. Maximum Drain Current Vs. Case Temperature

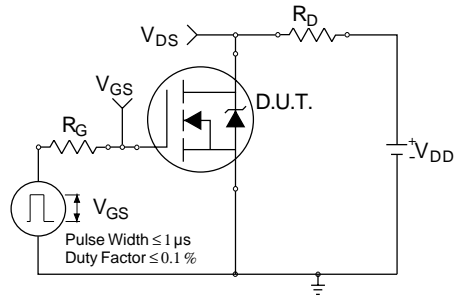


Fig 10a. Switching Time Test Circuit



Fig 10b. Switching Time Waveforms

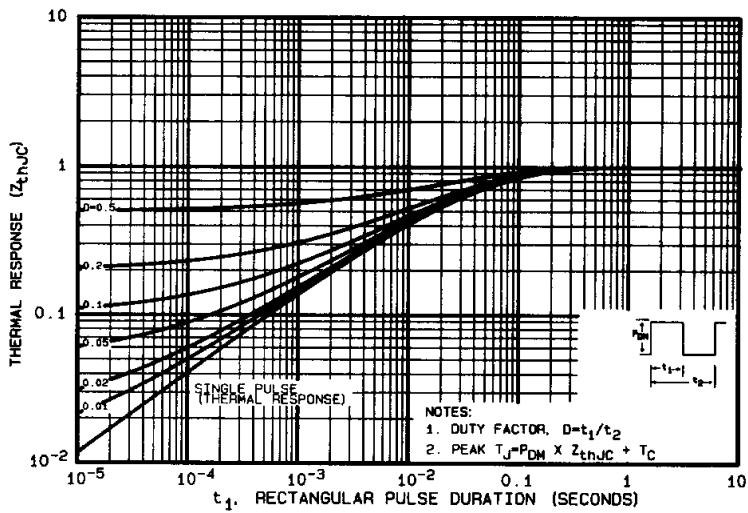
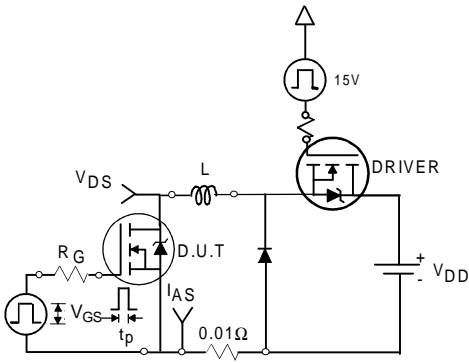
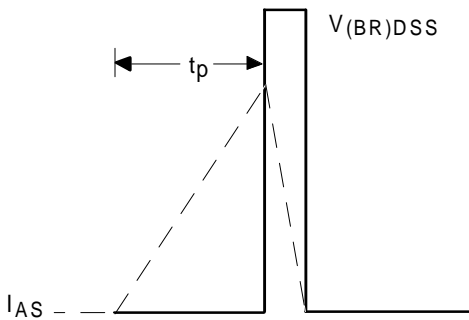


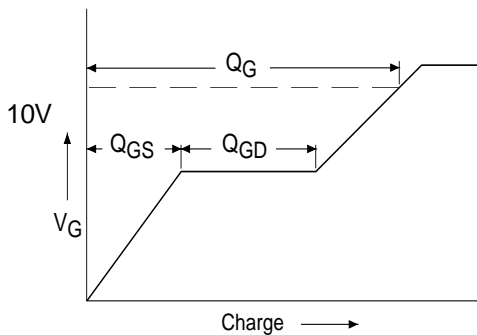
Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case



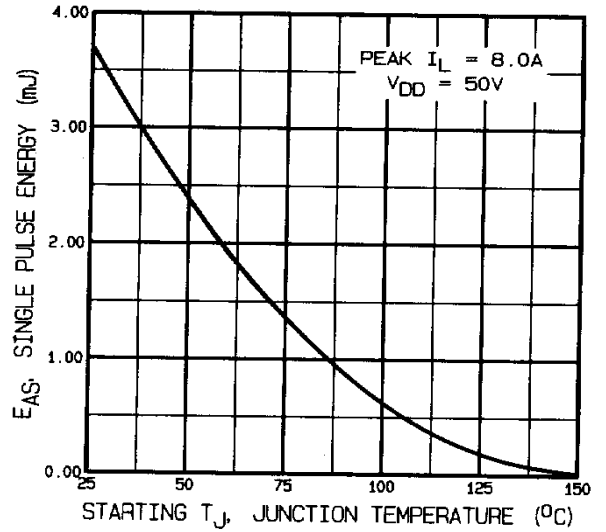
**Fig 12a.** Unclamped Inductive Test Circuit



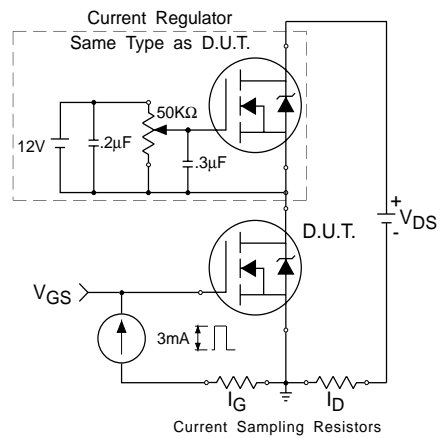
**Fig 12b.** Unclamped Inductive Waveforms



**Fig 13a.** Basic Gate Charge Waveform



**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current

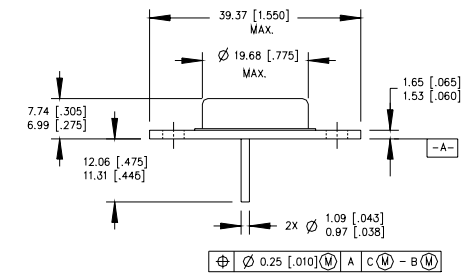


**Fig 13b.** Gate Charge Test Circuit

**Foot Notes:**

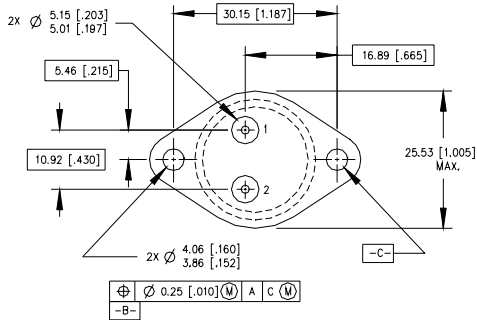
- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 50V$ , starting  $T_J = 25^{\circ}C$ ,  
Peak  $I_L = 8.0A$ ,
- ③  $I_{SD} \leq 8.0$ ,  $di/dt \leq 100A/\mu s$ ,  
 $V_{DD} \leq 500V$ ,  $T_J \leq 150^{\circ}C$   
Suggested  $RG = 9.1 \Omega$
- ④ Pulse width  $\leq 300 \mu s$ ; Duty Cycle  $\leq 2\%$

**Case Outline and Dimensions —TO-204AA (Modified TO-3)**



PIN ASSIGNMENTS

HEXFET	SCHOTTKY	IGBT
1 - SOURCE	1 - ANODE 1	1 - GATE
2 - GATE	2 - ANODE 2	2 - EMITTER
3 - DRAIN (CASE)	3 - COMMON CATHODE (CASE)	3 - COLLECTOR (CASE)



NOTES:

1. DIMENSIONING & TOLERANCING PER ANSI Y14.5M-1982.
2. CONTROLLING DIMENSION : INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. OUTLINE CONFORMS TO JEDEC OUTLINE TO-204-AA.