

# IRFI4410ZGPbF

HEXFET® Power MOSFET

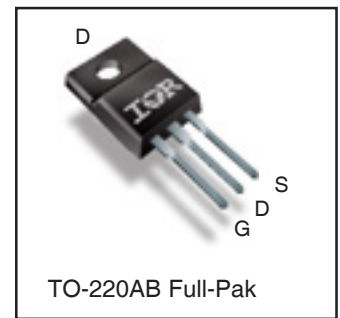
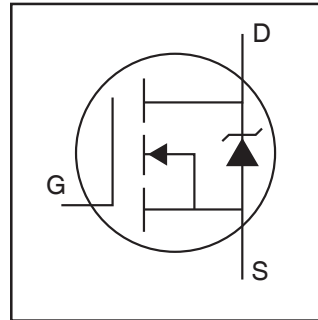
## Applications

- High Efficiency Synchronous Rectification in SMPS
- Uninterruptible Power Supply
- High Speed Power Switching
- Hard Switched and High Frequency Circuits

## Benefits

- Improved Gate, Avalanche and Dynamic dV/dt Ruggedness
- Fully Characterized Capacitance and Avalanche SOA
- Enhanced body diode dV/dt and dI/dt Capability
- Lead-Free
- Halogen-Free

$V_{DSS}$	<b>100V</b>
$R_{DS(on)}$ <b>typ.</b>	<b>7.9mΩ</b>
	<b>9.3mΩ</b>
$I_D$	<b>43A</b>



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

## Absolute Maximum Ratings

Symbol	Parameter	Max.	Units
$I_D @ T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$	43	A
$I_D @ T_C = 100^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$	30	
$I_{DM}$	Pulsed Drain Current ①	170	
$P_D @ T_C = 25^\circ\text{C}$	Maximum Power Dissipation	47	W
	Linear Derating Factor	0.3	W/°C
$V_{GS}$	Gate-to-Source Voltage	±30	V
$E_{AS}$ (Thermally limited)	Single Pulse Avalanche Energy ②	310	mJ
$T_J$	Operating Junction and Storage Temperature Range	-55 to + 175	°C
$T_{STG}$			
	Soldering Temperature, for 10 seconds (1.6mm from case)	300	
	Mounting torque, 6-32 or M3 screw	10lb·in (1.1N·m)	

## Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ④	—	3.2	°C/W
$R_{\theta JA}$	Junction-to-Ambient ④	—	65	

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	100	---	---	V	$V_{GS} = 0V, I_D = 250\mu\text{A}$
$V_{(BR)DSS}/T_J$	Breakdown Voltage Temp. Coefficient	---	95	---	mV/°C	Reference to $25^\circ\text{C}$ , $I_D = 5\text{mA}$ ③
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	---	7.9	9.3	m	$V_{GS} = 10V, I_D = 26A$ ③
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	$V_{DS} = V_{GS}, I_D = 150\mu\text{A}$
$I_{DSS}$	Drain-to-Source Leakage Current	---	---	20	$\mu\text{A}$	$V_{DS} = 100V, V_{GS} = 0V$
		---	---	250		$V_{DS} = 100V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	---	---	100	nA	$V_{GS} = 20V$
	Gate-to-Source Reverse Leakage	---	---	-100		$V_{GS} = -20V$
$R_{G(int)}$	Internal Gate Resistance	---	0.9	---		

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
gfs	Forward Transconductance	80	---	---	S	$V_{DS} = 50V, I_D = 26A$
$Q_g$	Total Gate Charge	---	81	110	nC	$I_D = 26A$
$Q_{gs}$	Gate-to-Source Charge	---	18	---		$V_{DS} = 50V$
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	---	23	---		$V_{GS} = 10V$ ③
$t_{d(on)}$	Turn-On Delay Time	---	15	---	ns	$V_{DD} = 65V$
$t_r$	Rise Time	---	27	---		$I_D = 26A$
$t_{d(off)}$	Turn-Off Delay Time	---	43	---		$R_G = 2.7$
$t_f$	Fall Time	---	30	---		$V_{GS} = 10V$ ③
$C_{iss}$	Input Capacitance	---	4910	---		$V_{GS} = 0V$
$C_{oss}$	Output Capacitance	---	330	---	$V_{DS} = 50V$ $f = 1.0\text{MHz}$	
$C_{rss}$	Reverse Transfer Capacitance	---	150	---		
$C_{oss \text{ eff. (ER)}}$	Effective Output Capacitance (Energy Related)	---	420	---		$V_{GS} = 0V, V_{DS} = 0V \text{ to } 80V$ ⑥, See Fig.11
$C_{oss \text{ eff. (TR)}}$	Effective Output Capacitance (Time Related)	---	680	---	$V_{GS} = 0V, V_{DS} = 0V \text{ to } 80V$ ⑤	

## Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_S$	Continuous Source Current (Body Diode)	---	---	43	A	MOSFET symbol showing the integral reverse p-n junction diode.
$I_{SM}$	Pulsed Source Current (Body Diode) ①	---	---	170	A	
$V_{SD}$	Diode Forward Voltage	---	---	1.3	V	$T_J = 25^\circ\text{C}, I_S = 26A, V_{GS} = 0V$ ③
$t_{rr}$	Reverse Recovery Time	---	47	71	ns	$T_J = 25^\circ\text{C}$
		---	54	81		$T_J = 125^\circ\text{C}$
$Q_{rr}$	Reverse Recovery Charge	---	110	160	nC	$T_J = 25^\circ\text{C}$
		---	140	210		$T_J = 125^\circ\text{C}$
$I_{RRM}$	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  $T_J = 25^\circ\text{C}$ ,  $L = 0.91\text{mH}$   
 $R_G = 25\Omega, I_{AS} = 26A, V_{GS} = 10V$ . Part not recommended for use above this value.

- ③ Pulse width  $\leq 400\mu\text{s}$ ; duty cycle  $\leq 2\%$ .  
 ④  $R_\theta$  is measured at  $T_J$  approximately  $90^\circ\text{C}$   
 ⑤  $C_{oss \text{ eff. (TR)}}$  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  $C_{oss \text{ eff. (ER)}}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

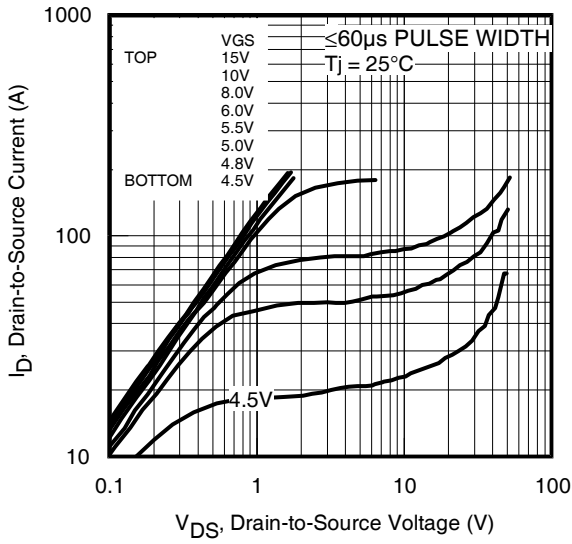


Fig 1. Typical Output Characteristics

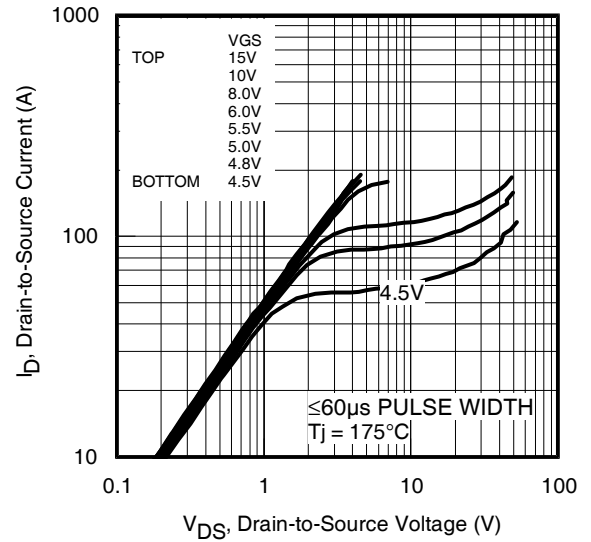


Fig 2. Typical Output Characteristics

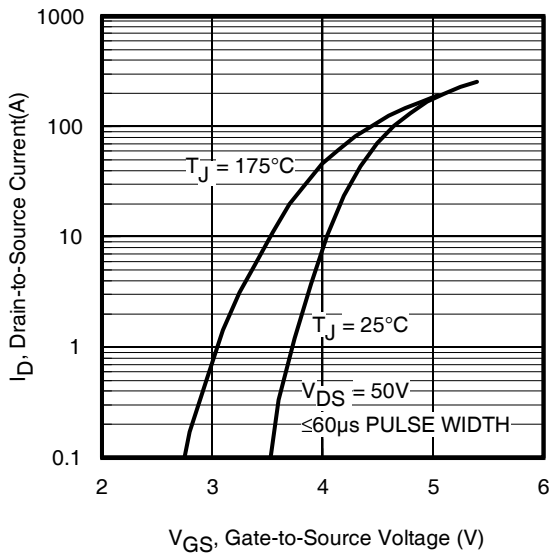


Fig 3. Typical Transfer Characteristics

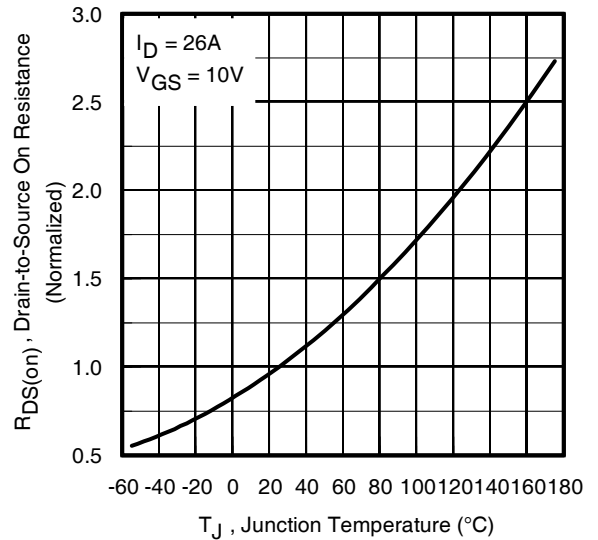


Fig 4. Normalized On-Resistance vs. Temperature

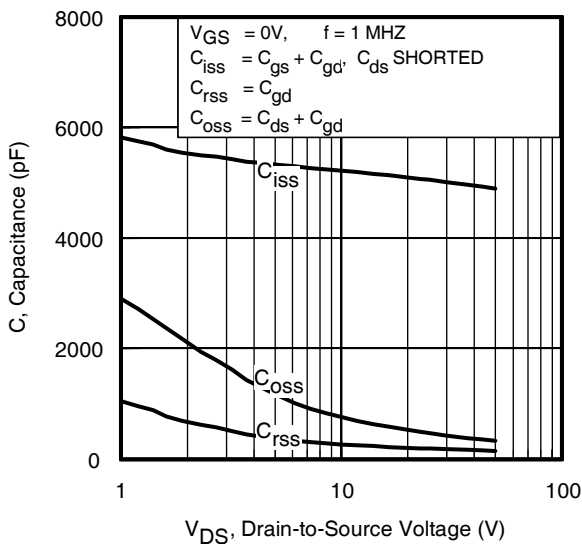


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

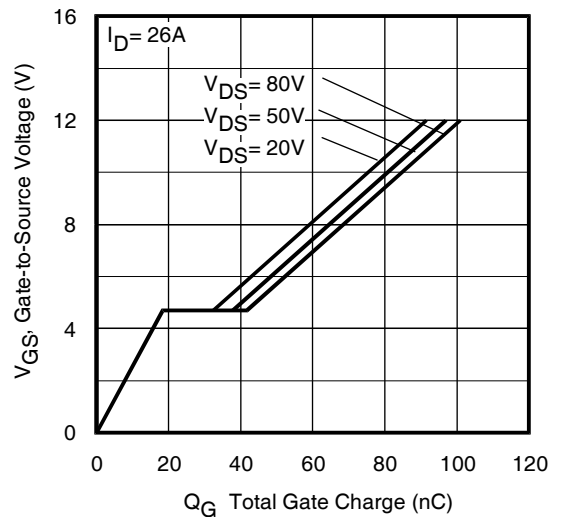
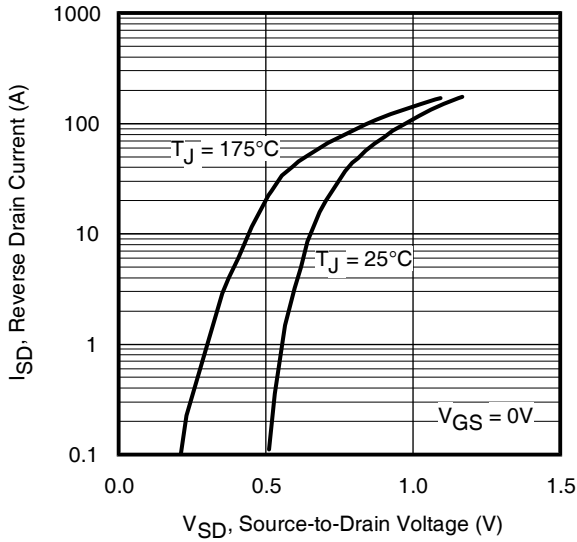
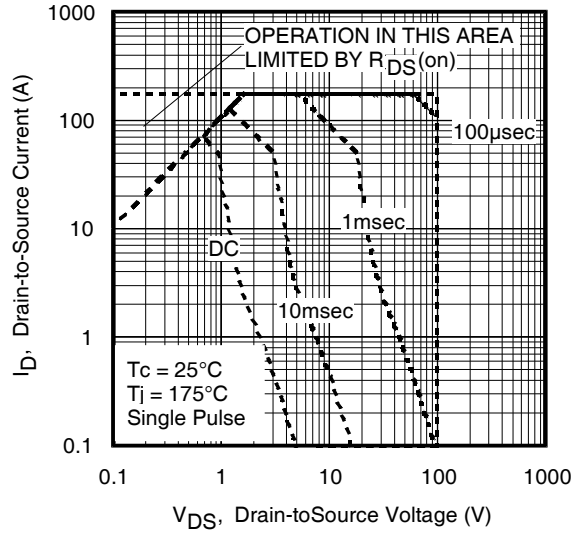


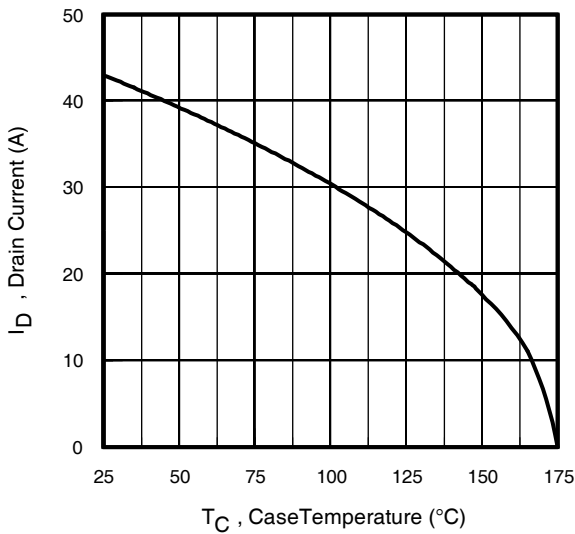
Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage



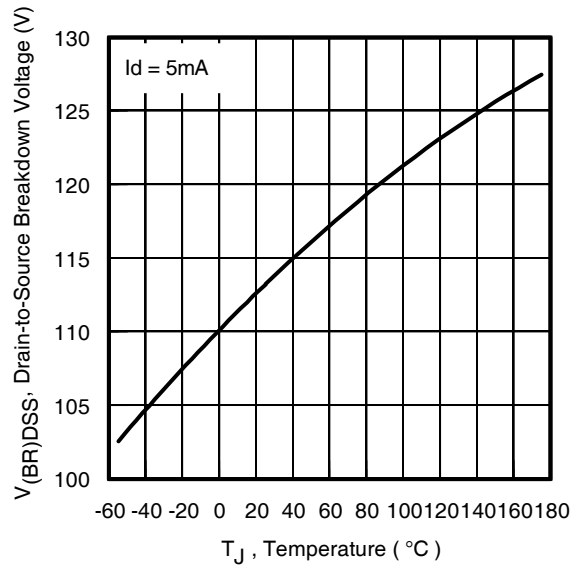
**Fig 7.** Typical Source-Drain Diode Forward Voltage



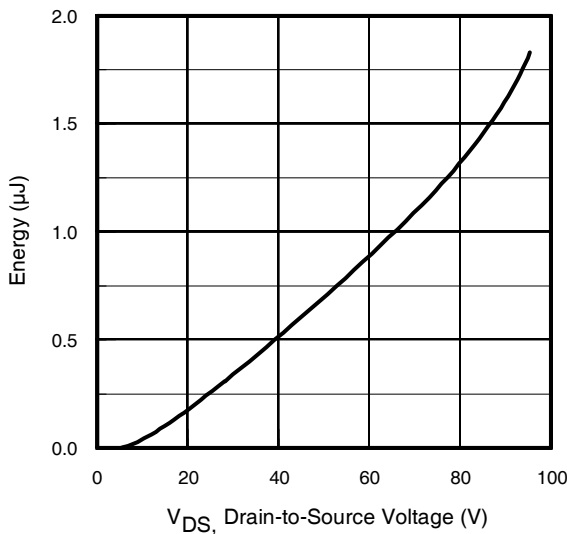
**Fig 8.** Maximum Safe Operating Area



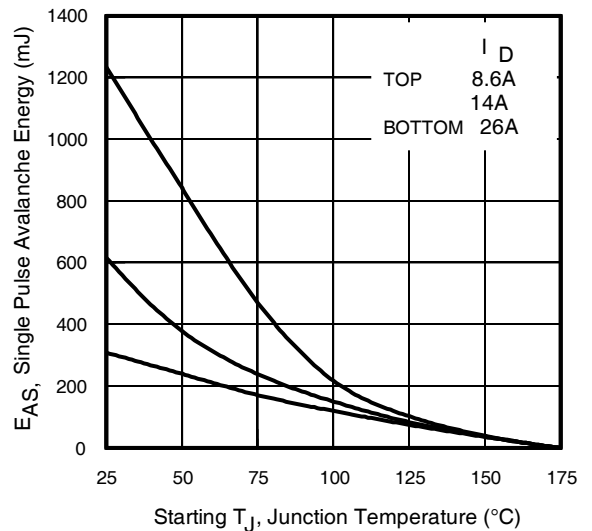
**Fig 9.** Maximum Drain Current vs. Case Temperature



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



**Fig 11.** Typical  $C_{OSS}$  Stored Energy



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

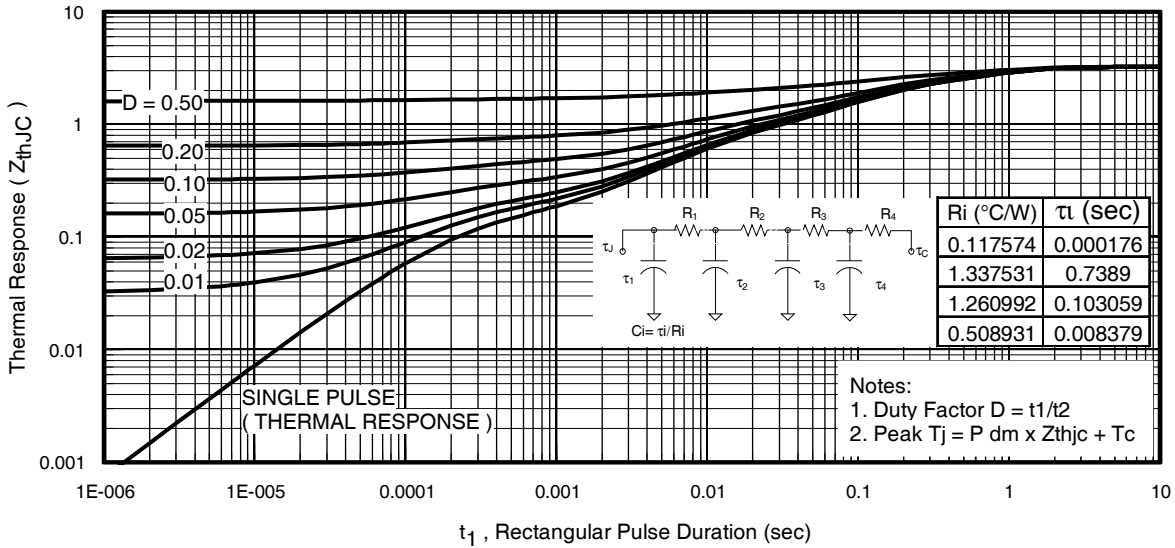


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

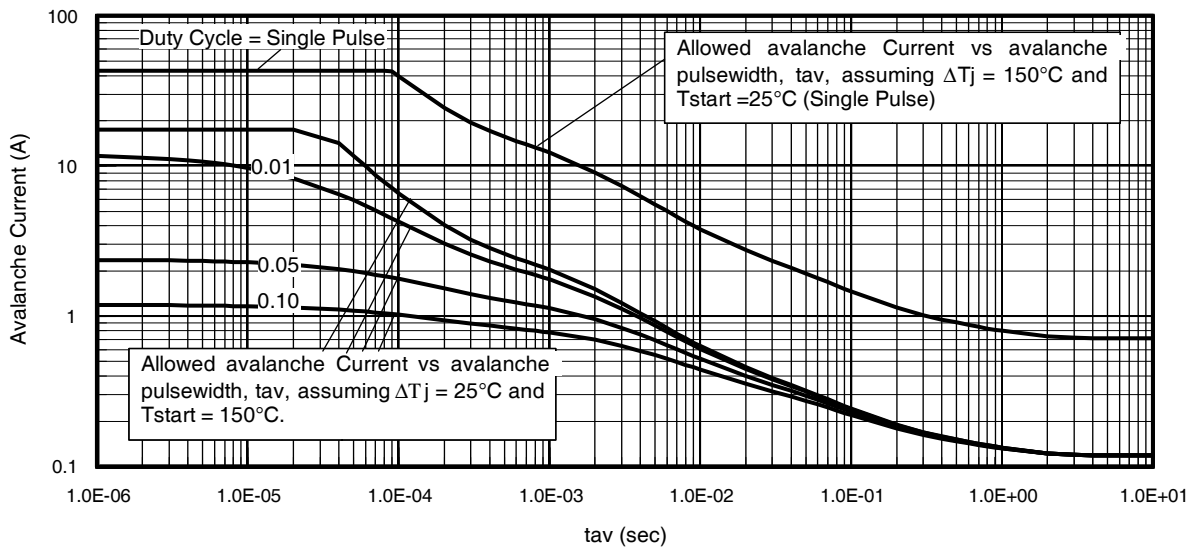
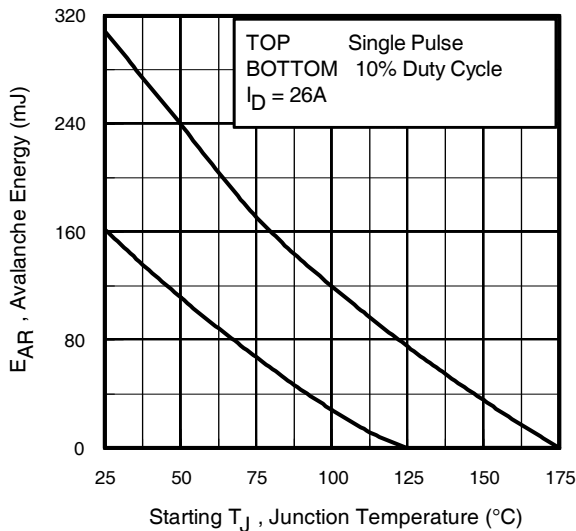


Fig 14. Typical Avalanche Current vs. Pulsewidth



**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 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.  $\Delta T$  = 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 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 15. Maximum Avalanche Energy vs. Temperature

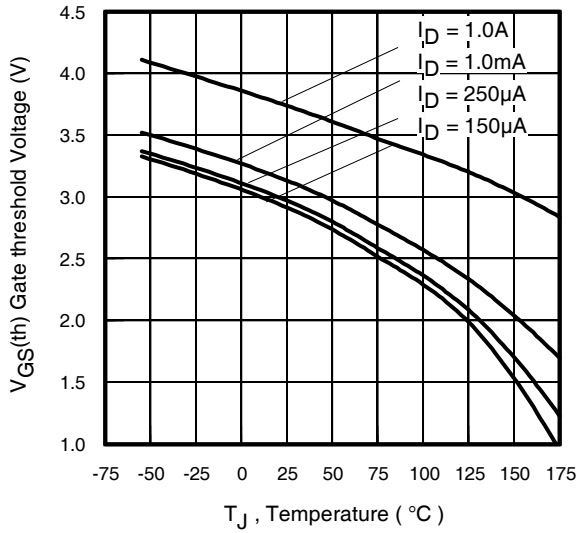


Fig 16. Threshold Voltage Vs. Temperature

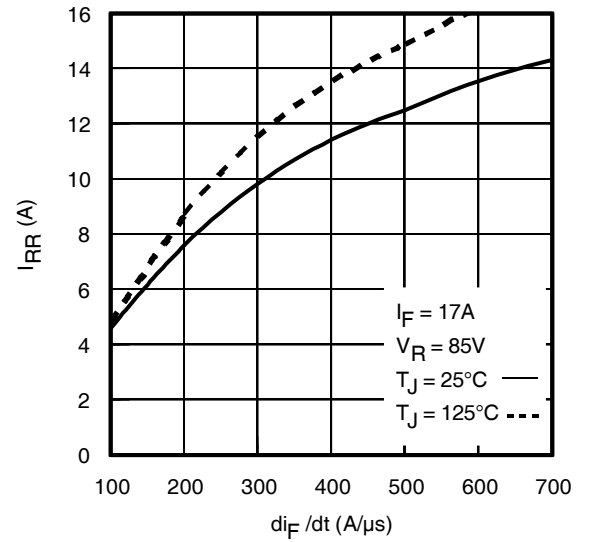


Fig. 17 - Typical Recovery Current vs. di/dt

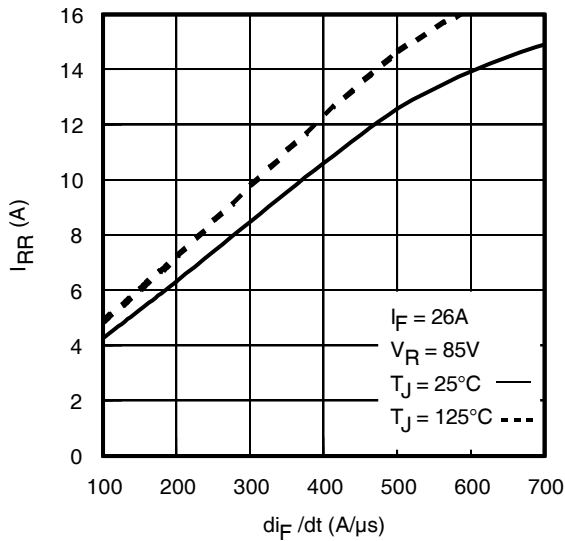


Fig. 18 - Typical Recovery Current vs. di/dt

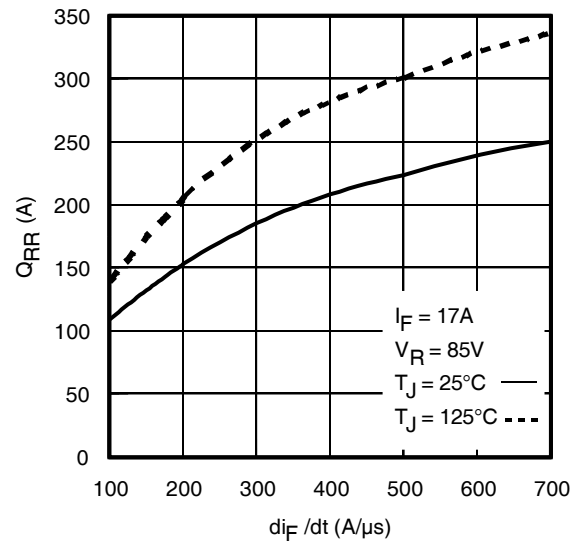


Fig. 19 - Typical Stored Charge vs. di/dt

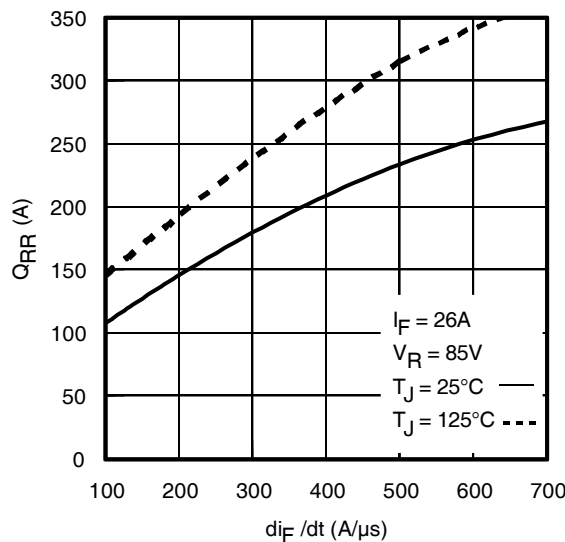
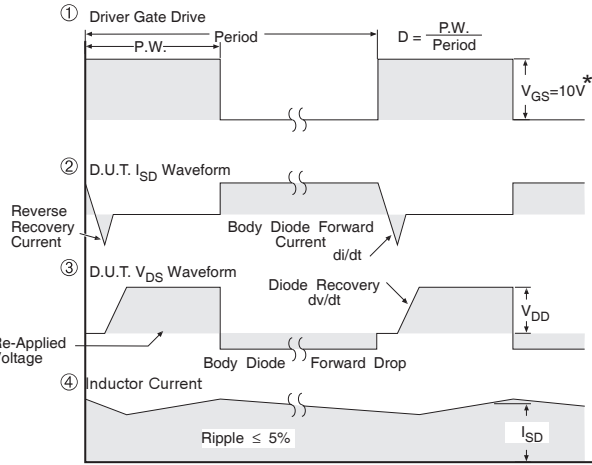
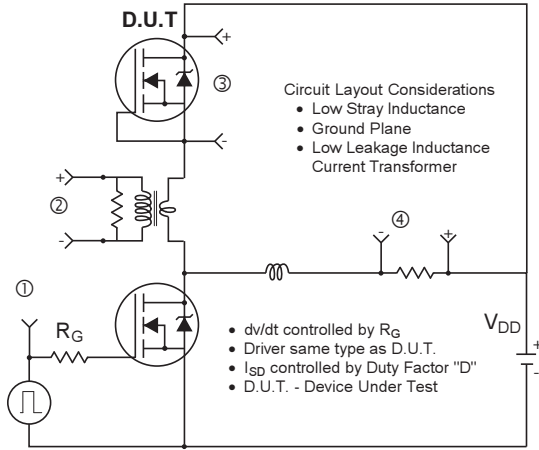
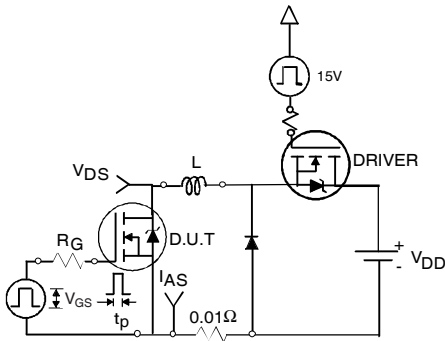


Fig. 20 - Typical Stored Charge vs. di/dt

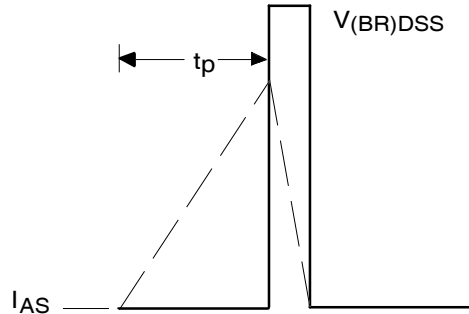


\*  $V_{GS} = 5V$  for Logic Level Devices

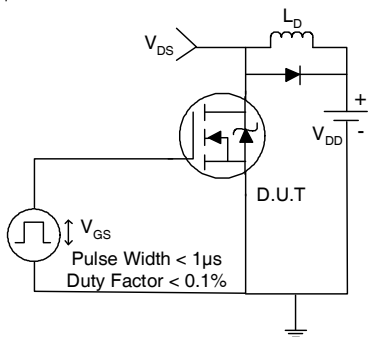
**Fig 21. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs**



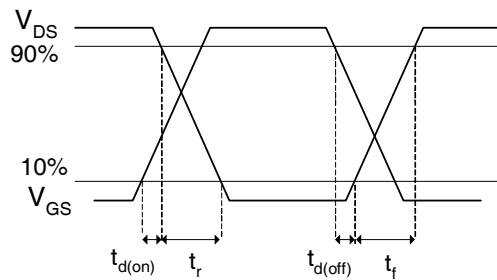
**Fig 22a. Unclamped Inductive Test Circuit**



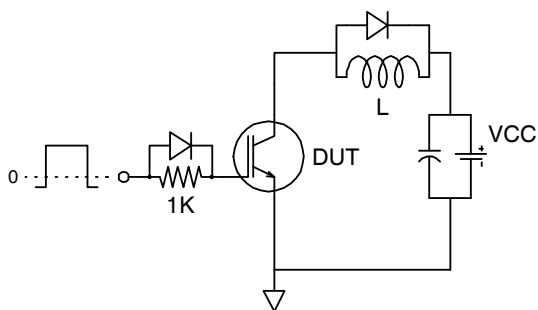
**Fig 22b. Unclamped Inductive Waveforms**



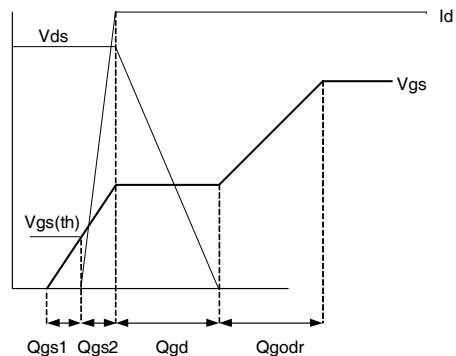
**Fig 23a. Switching Time Test Circuit**



**Fig 23b. Switching Time Waveforms**

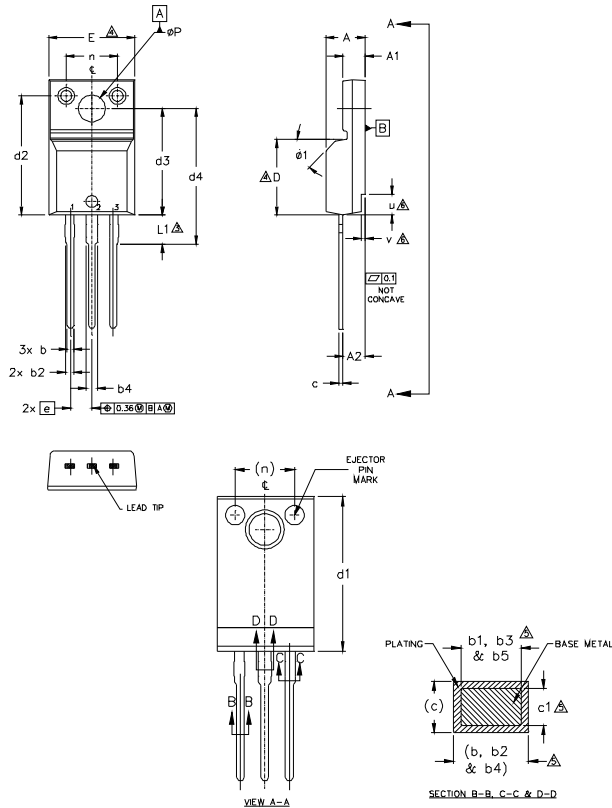


**Fig 24a. Gate Charge Test Circuit**



**Fig 24b. Gate Charge Waveform**

TO-220AB Full-Pak Package Outline (Dimensions are shown in millimeters (inches))



- NOTES:
- 1.0 DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M- 1994.
  - 2.0 DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
  - 3.0 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
  - 4.0 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTER MOST EXTREMES OF THE PLASTIC BODY.
  - 5.0 DIMENSION b1, b3, b5 & c1 APPLY TO BASE METAL ONLY.
  - 6.0 STEP OPTIONAL ON PLASTIC BODY DEFINED BY DIMENSIONS u & v.
  - 7.0 CONTROLLING DIMENSION : INCHES.

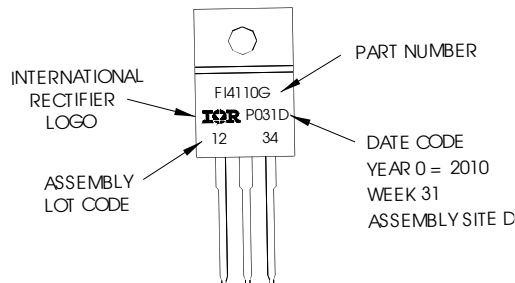
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.57	4.83	.180	.190	5
A1	2.57	2.83	.101	.111	
A2	2.41	2.92	.095	.115	
b	0.62	.094	0.24	.035	
b1	0.62	0.89	.024	0.35	
b2	0.76	1.27	.030	.050	
b3	0.76	1.22	.030	.048	
b4	1.02	1.52	.040	.060	
b5	1.02	1.47	.040	.058	
c	0.33	0.63	.013	.025	
c1	0.33	0.58	.013	.023	5
D	8.65	9.80	.341	.386	4
d1	15.80	16.12	.622	.635	4
d2	13.97	14.22	.550	.560	
d3	12.30	12.92	.484	.509	
d4	8.64	9.91	.340	.390	
E	9.63	10.63	.379	.419	
e	2.54 BSC		.100 BSC		4
L	13.20	13.72	.520	.540	3
L1	3.10	2.31	.122	.138	
n	6.05	6.15	.238	.242	6
ϕP	3.05	3.45	.120	.136	
u	2.40	2.50	.094	.098	6
v	0.40	0.50	.016	.020	6
ϕ1	-	45°	-	45°	

- LEAD ASSIGNMENTS
- HEXFLET
- 1.- GATE
  - 2.- DRAIN
  - 3.- SOURCE
- IGBTs, CoPACK
- 1.- GATE
  - 2.- COLLECTOR
  - 3.- EMITTER

TO-220AB Full-Pak Part Marking Information

EXAMPLE: THIS IS AN IRFI4110G  
WITH ASSEMBLY  
LOT CODE 1234  
ASSEMBLED ON WW31, 2010

Notes: - "P" in assembly line position  
indicates "Lead-Free"  
- "G" suffix in part number  
indicates "Halogen-Free"



TO-220AB Full-Pak packages are not recommended for Surface Mount Application.

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

Data and specifications subject to change without notice.  
This product has been designed and qualified for the Industrial market.  
Qualification Standards can be found on IR's Web site.