

IRFI4410ZGPbF

HEXFET® Power MOSFET

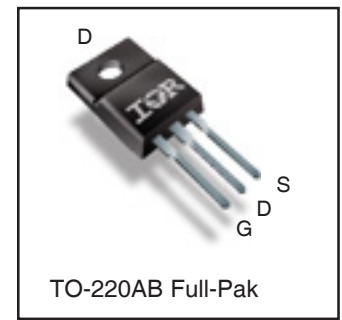
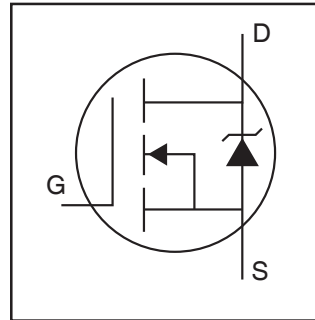
Applications

- 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}	100V
$R_{DS(on)}$ typ.	7.9mΩ
	9.3mΩ
I_D	43A



G	D	S
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°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	μA	$V_{DS} = 100V, V_{GS} = 0V$
		—	—	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	—		pF
C_{oss}	Output Capacitance	—	330	—	$V_{DS} = 50V$	
C_{rss}	Reverse Transfer Capacitance	—	150	—	$f = 1.0\text{MHz}$	
$C_{oss \text{ eff. (ER)}}$	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_θ is measured at T_J approximately 90°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} .

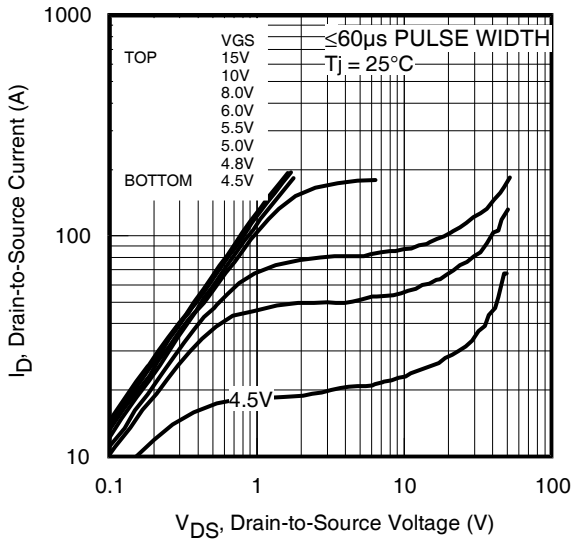


Fig 1. Typical Output Characteristics

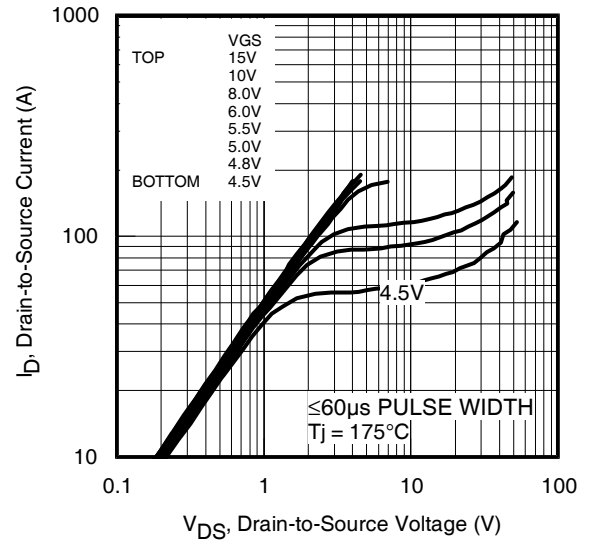


Fig 2. Typical Output Characteristics

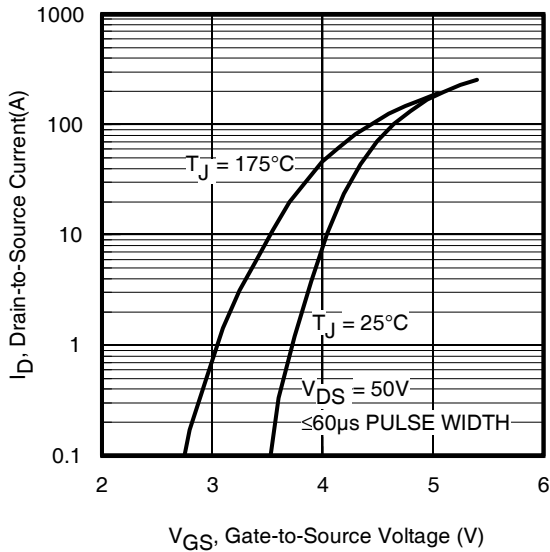


Fig 3. Typical Transfer Characteristics

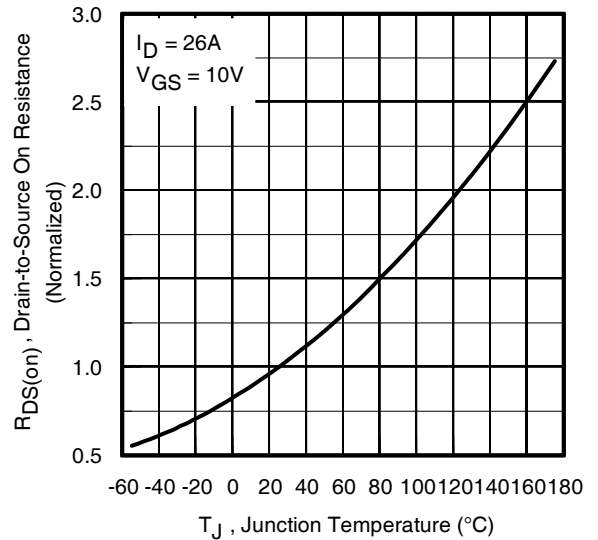


Fig 4. Normalized On-Resistance vs. Temperature

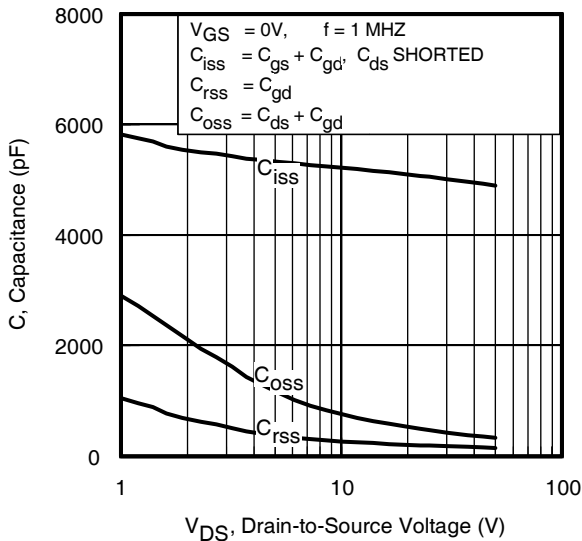


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

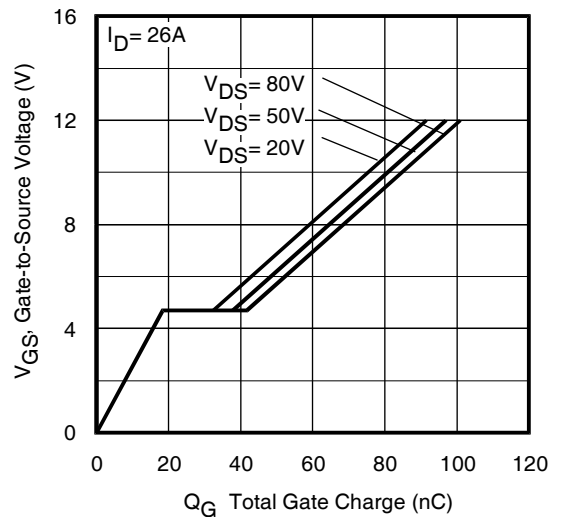


Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage

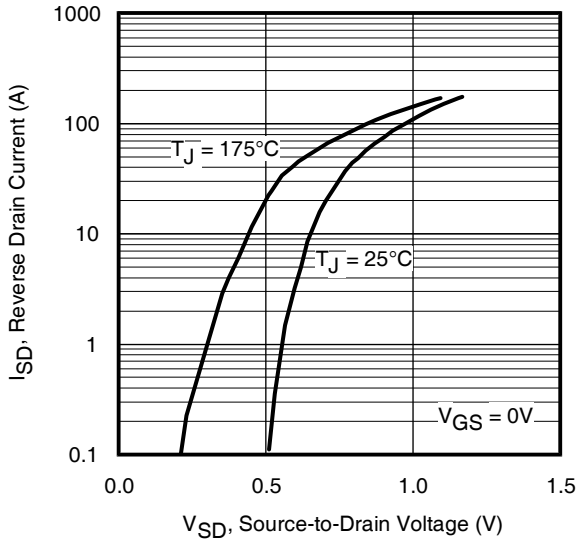


Fig 7. Typical Source-Drain Diode Forward Voltage

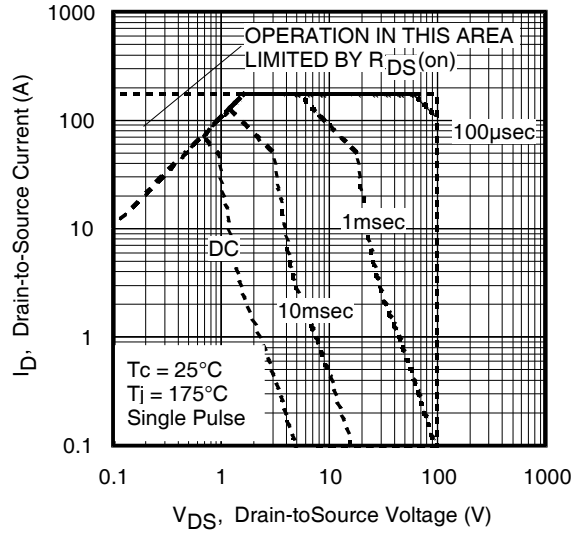


Fig 8. Maximum Safe Operating Area

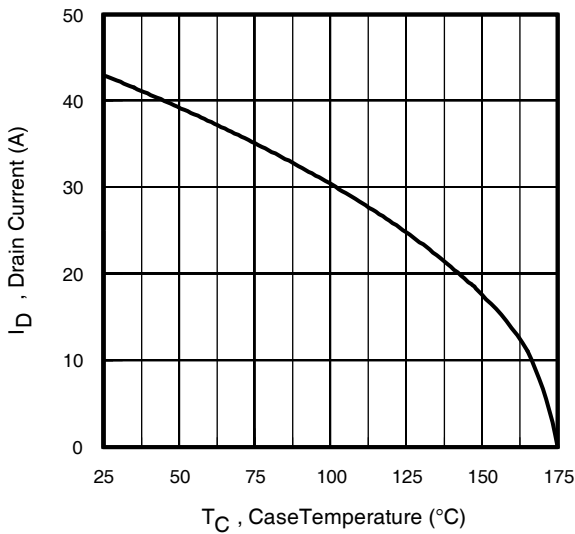


Fig 9. Maximum Drain Current vs. Case Temperature

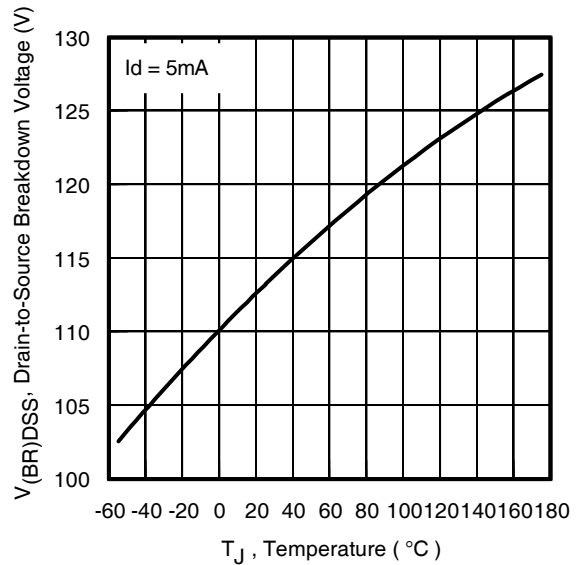


Fig 10. Drain-to-Source Breakdown Voltage

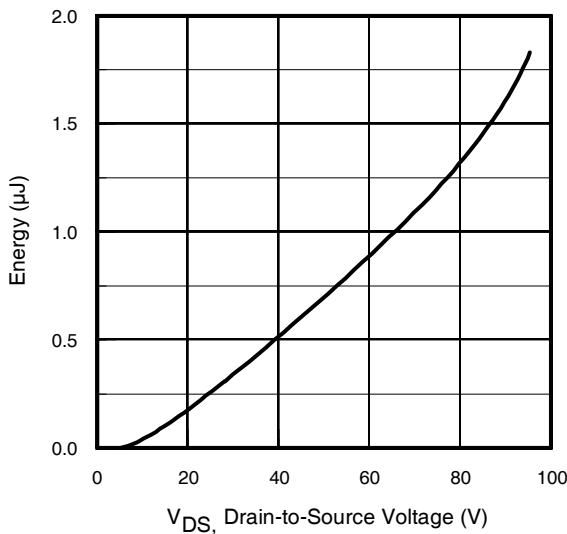


Fig 11. Typical C_{OSS} Stored Energy

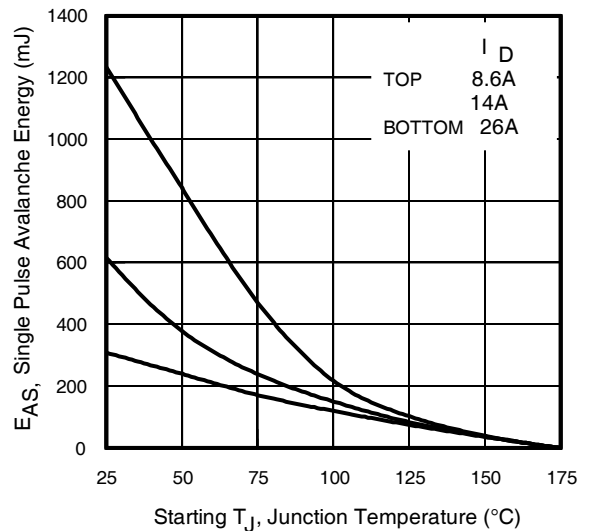


Fig 12. Maximum Avalanche Energy Vs. Drain Current

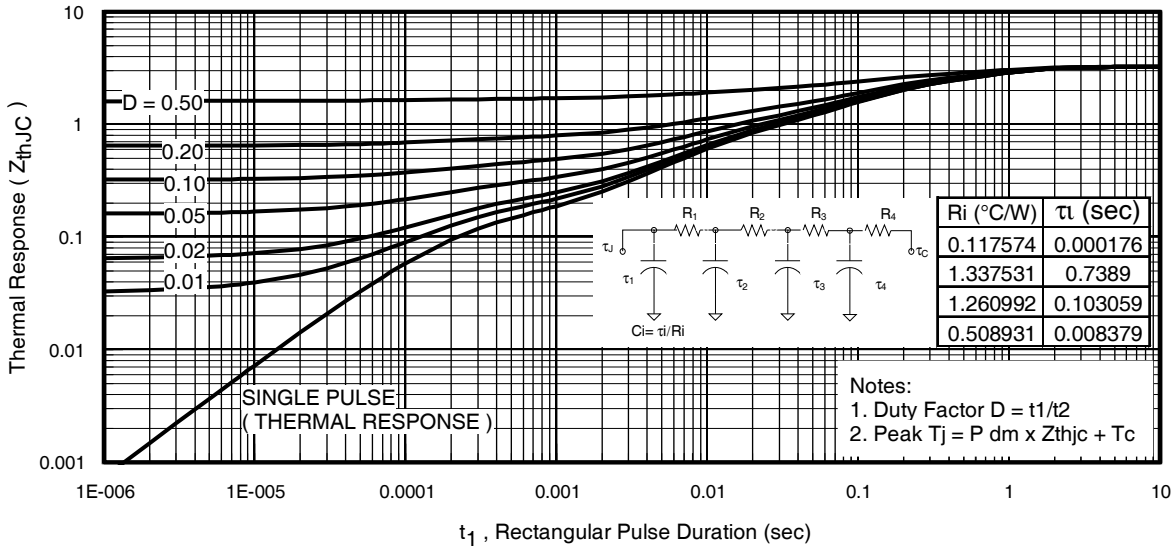


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

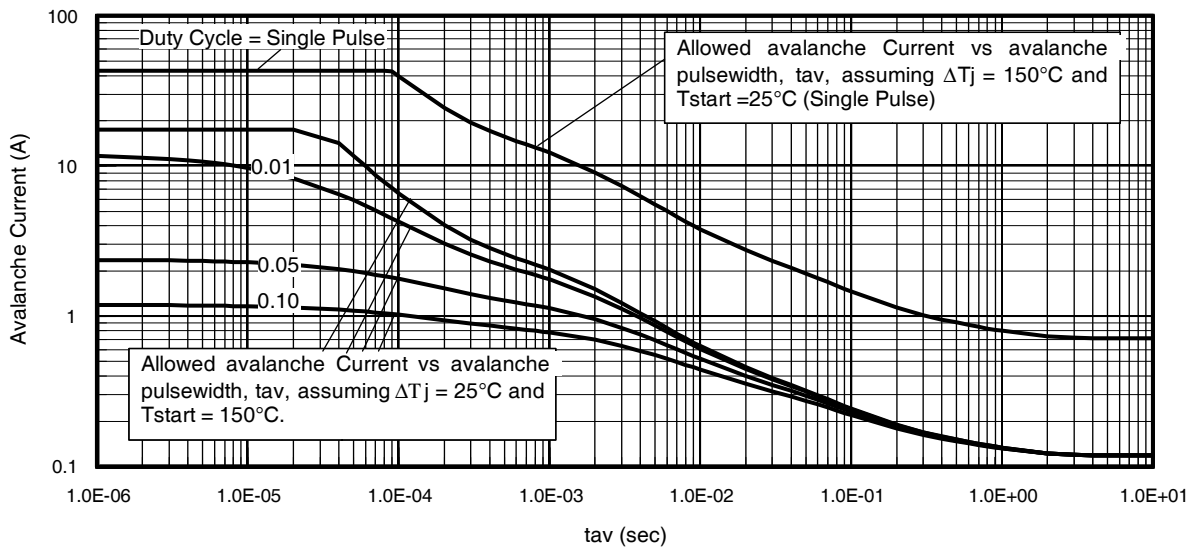
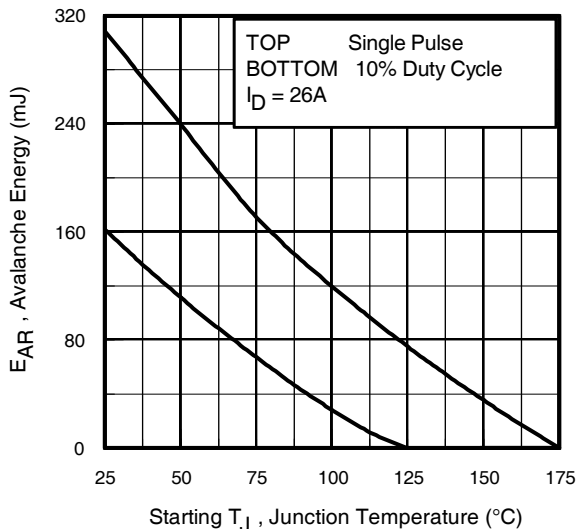


Fig 14. Typical Avalanche Current vs. Pulsewidth



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

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. 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 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

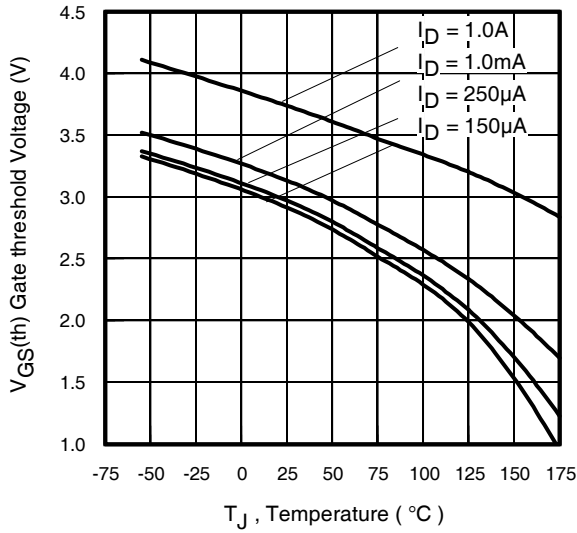


Fig 16. Threshold Voltage Vs. Temperature

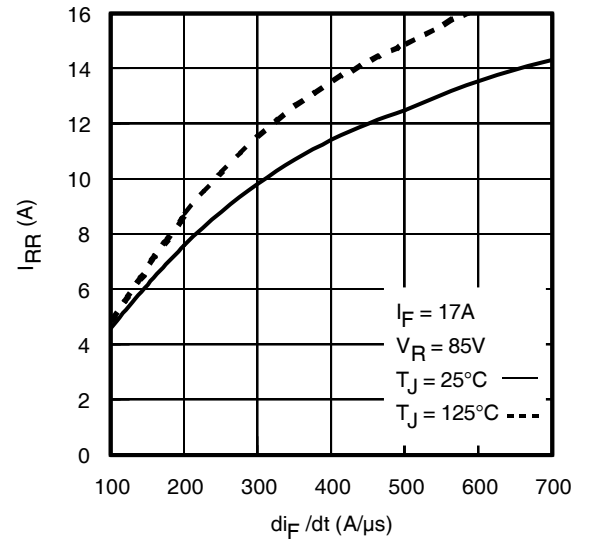


Fig. 17 - Typical Recovery Current vs. di_F/dt

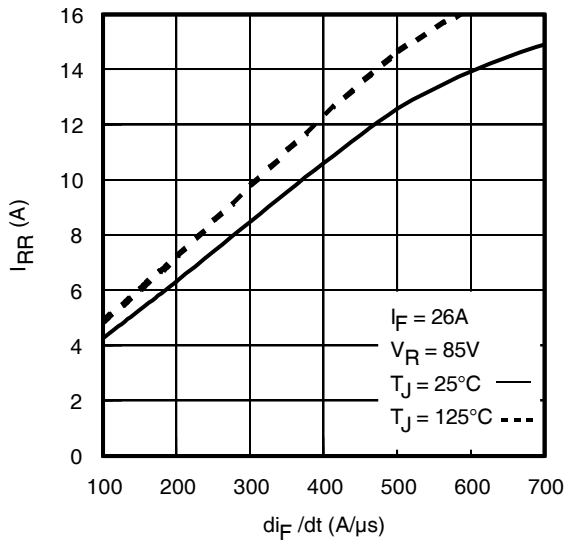


Fig. 18 - Typical Recovery Current vs. di_F/dt

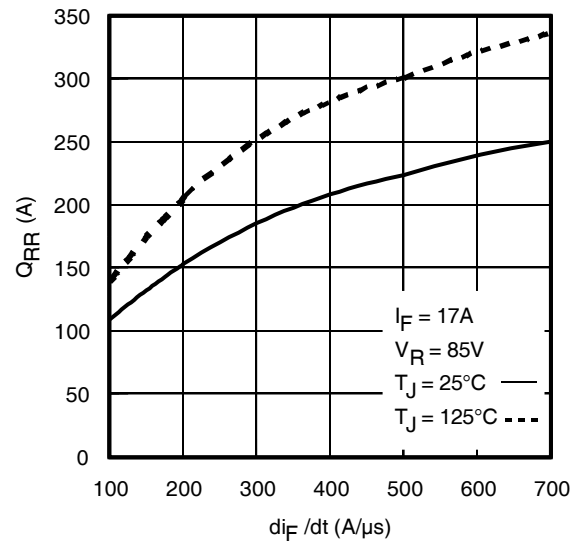


Fig. 19 - Typical Stored Charge vs. di_F/dt

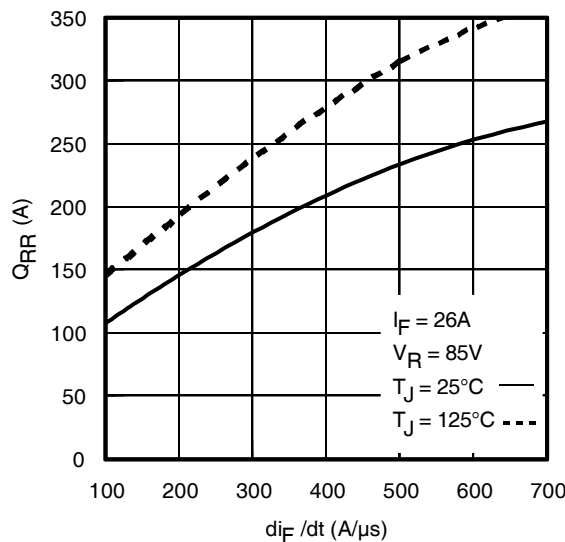
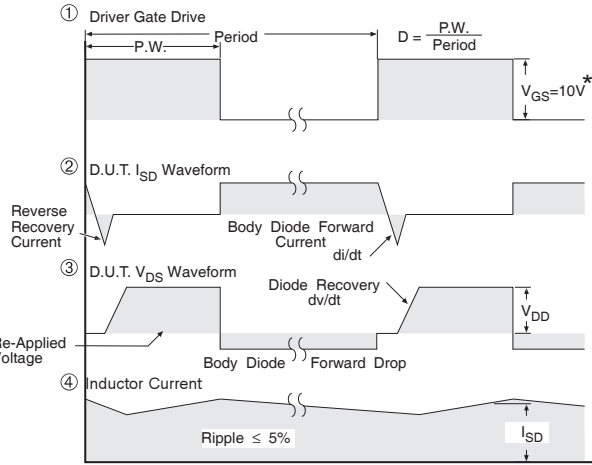
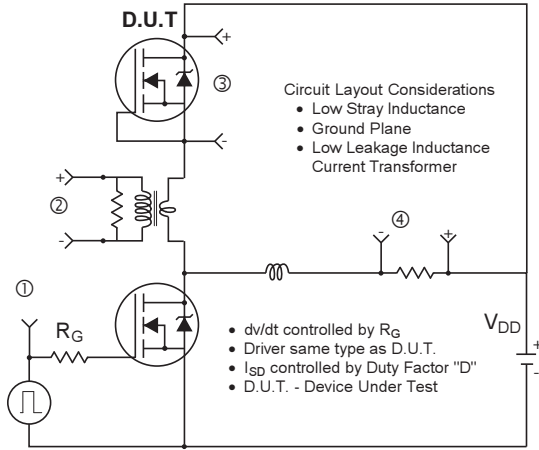


Fig. 20 - Typical Stored Charge vs. di_F/dt



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

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

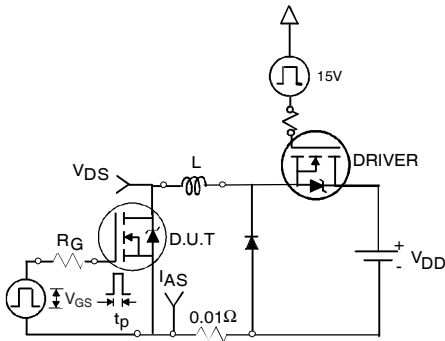


Fig 22a. Unclamped Inductive Test Circuit



Fig 22b. Unclamped Inductive Waveforms

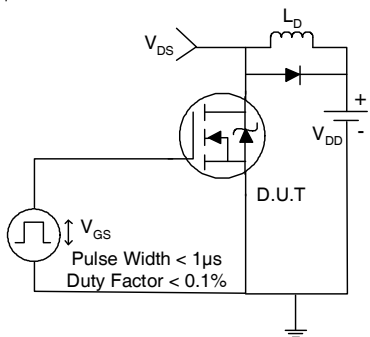


Fig 23a. Switching Time Test Circuit

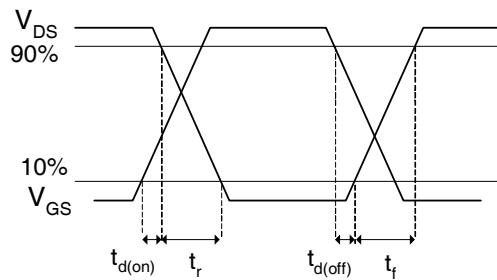


Fig 23b. Switching Time Waveforms

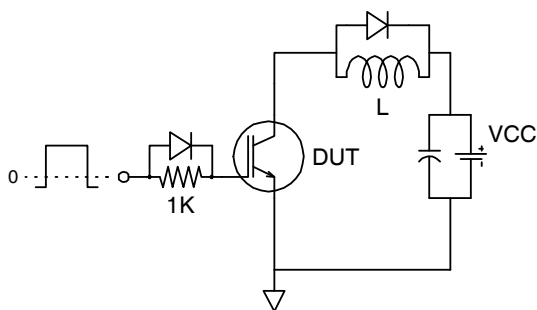
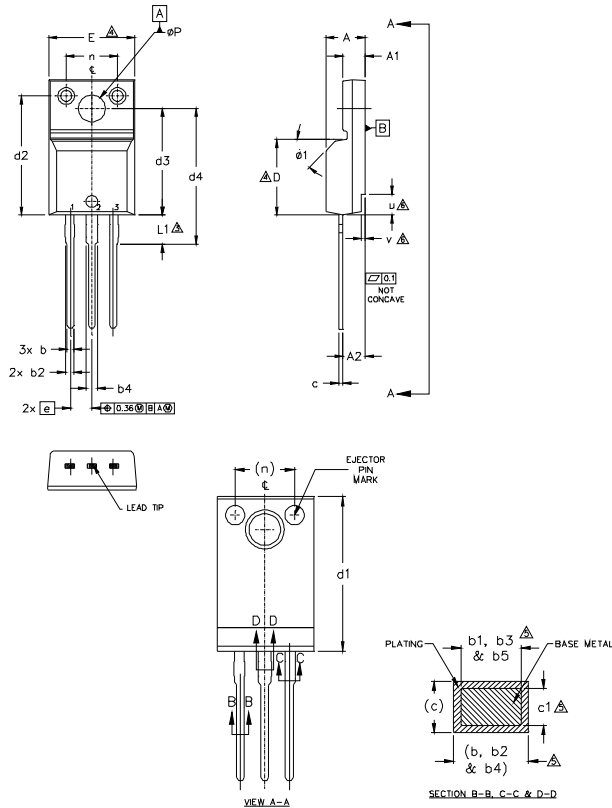


Fig 24a. Gate Charge Test Circuit



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		3
L	13.20	13.72	.520	.540	
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	
ϕ1	-	45°	-	45°	

LEAD ASSIGNMENTS

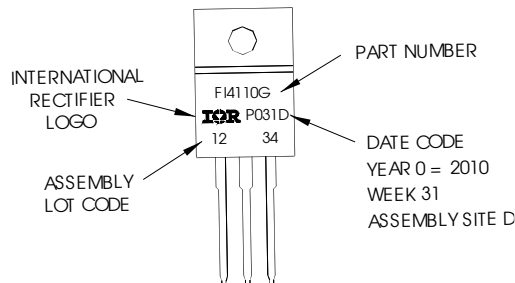
- HEXFLET
 1.- GATE
 2.- DRAIN
 3.- SOURCE

- 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.

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[SSM6P69NU,LF](#) [DMP22D4UFO-7B](#) [DMN1006UCA6-7](#)