

# IRFP21N60LPbF

HEXFET® Power MOSFET

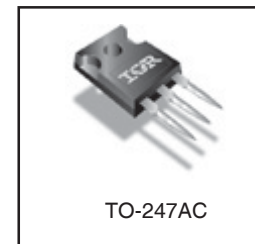
## Applications

- Zero Voltage Switching SMPS
- Telecom and Server Power Supplies
- Uninterruptible Power Supplies
- Motor Control applications
- Lead-Free

V <sub>DSS</sub>	R <sub>DS(on) typ.</sub>	T <sub>rr typ.</sub>	I <sub>D</sub>
600V	270mΩ	160ns	21A

## Features and Benefits

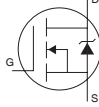
- SuperFast body diode eliminates the need for external diodes in ZVS applications.
- Lower Gate charge results in simpler drive requirements.
- Enhanced dv/dt capabilities offer improved ruggedness.
- Higher Gate voltage threshold offers improved noise immunity.



## Absolute Maximum Ratings

	Parameter	Max.	Units
I <sub>D</sub> @ T <sub>C</sub> = 25°C	Continuous Drain Current, V <sub>GS</sub> @ 10V	21	A
I <sub>D</sub> @ T <sub>C</sub> = 100°C	Continuous Drain Current, V <sub>GS</sub> @ 10V	13	
I <sub>DM</sub>	Pulsed Drain Current ①	84	
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Power Dissipation	330	W
	Linear Derating Factor	2.6	W/°C
V <sub>GS</sub>	Gate-to-Source Voltage	±30	V
dv/dt	Peak Diode Recovery dv/dt ②	11	V/ns
T <sub>J</sub>	Operating Junction and	-55 to + 150	°C
T <sub>STG</sub>	Storage Temperature Range		
	Soldering Temperature, for 10 seconds	300 (1.6mm from case )	
	Mounting torque, 6-32 or M3 screw	1.1(10)	N•m (lbf•in)

## Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	21	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I <sub>SM</sub>	Pulsed Source Current (Body Diode) ①	—	—	84		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.5	V	
t <sub>rr</sub>	Reverse Recovery Time	—	160	240	ns	T <sub>J</sub> = 25°C, I <sub>F</sub> = 21A
		—	400	610		T <sub>J</sub> = 125°C, di/dt = 100A/μs ④
Q <sub>rr</sub>	Reverse Recovery Charge	—	480	730	nC	T <sub>J</sub> = 25°C, I <sub>S</sub> = 21A, V <sub>GS</sub> = 0V ④
		—	1540	2310		T <sub>J</sub> = 125°C, di/dt = 100A/μs ④
I <sub>RRM</sub>	Reverse Recovery Current	—	5.3	7.9	A	T <sub>J</sub> = 25°C
t <sub>on</sub>	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD)				

# IRFP21N60LPbF

International  
IR Rectifier

## 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	600	—	—	V	$V_{GS} = 0V, I_D = 250\mu A$
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.42	—	V/°C	Reference to $25^\circ\text{C}, I_D = 1\text{mA}$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	270	320	m $\Omega$	$V_{GS} = 10V, I_D = 13A$ ④
$V_{GS(th)}$	Gate Threshold Voltage	3.0	—	5.0	V	$V_{DS} = V_{GS}, I_D = 250\mu A$
$I_{DSS}$	Drain-to-Source Leakage Current	—	—	50	$\mu A$	$V_{DS} = 600V, V_{GS} = 0V$
		—	—	2.0	mA	$V_{DS} = 480V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	—	—	100	nA	$V_{GS} = 30V$
	Gate-to-Source Reverse Leakage	—	—	-100	nA	$V_{GS} = -30V$
$R_G$	Internal Gate Resistance	—	0.63	—	$\Omega$	$f = 1\text{MHz}, \text{open drain}$

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$g_{fs}$	Forward Transconductance	11	—	—	S	$V_{DS} = 50V, I_D = 13A$
$Q_g$	Total Gate Charge	—	—	150	nC	$I_D = 21A$
$Q_{gs}$	Gate-to-Source Charge	—	—	46	nC	$V_{DS} = 480V$
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	—	—	64	nC	$V_{GS} = 10V, \text{See Fig. 7 \& 15 } \textcircled{4}$
$t_{d(on)}$	Turn-On Delay Time	—	20	—	ns	$V_{DD} = 300V$
$t_r$	Rise Time	—	58	—	ns	$I_D = 21A$
$t_{d(off)}$	Turn-Off Delay Time	—	33	—	ns	$R_G = 1.3\Omega$
$t_f$	Fall Time	—	10	—	ns	$V_{GS} = 10V, \text{See Fig. 11a \& 11b } \textcircled{4}$
$C_{iss}$	Input Capacitance	—	4000	—	pF	$V_{GS} = 0V$
$C_{oss}$	Output Capacitance	—	340	—	pF	$V_{DS} = 25V$
$C_{rss}$	Reverse Transfer Capacitance	—	29	—	pF	$f = 1.0\text{MHz}, \text{See Fig. 5}$
$C_{oss \text{ eff.}}$	Effective Output Capacitance	—	170	—	pF	$V_{GS} = 0V, V_{DS} = 0V \text{ to } 480V \textcircled{5}$
$C_{oss \text{ eff. (ER)}}$	Effective Output Capacitance (Energy Related)	—	130	—	pF	

## Avalanche Characteristics

Symbol	Parameter	Typ.	Max.	Units
$E_{AS}$	Single Pulse Avalanche Energy ②	—	420	mJ
$I_{AR}$	Avalanche Current ①	—	21	A
$E_{AR}$	Repetitive Avalanche Energy ①	—	33	mJ

## Thermal Resistance

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	0.38	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient	—	40	

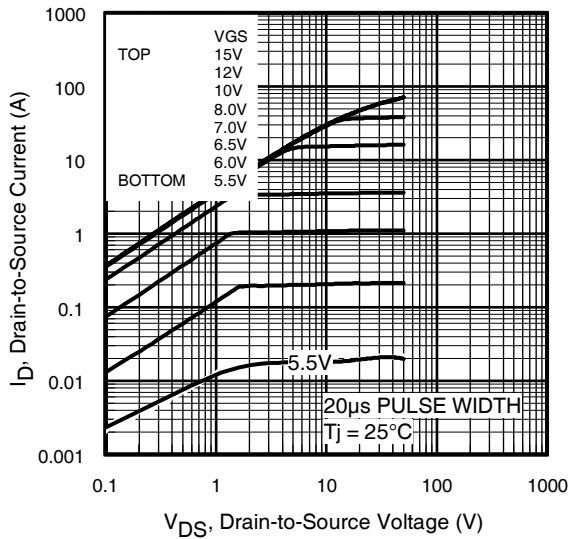
### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See Fig. 11)
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 1.9\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 21A$ ,  $dv/dt = 11V/ns$ . (See Figure 12a)
- ③  $I_{SD} \leq 21A$ ,  $di/dt \leq 530A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 150^\circ\text{C}$ .

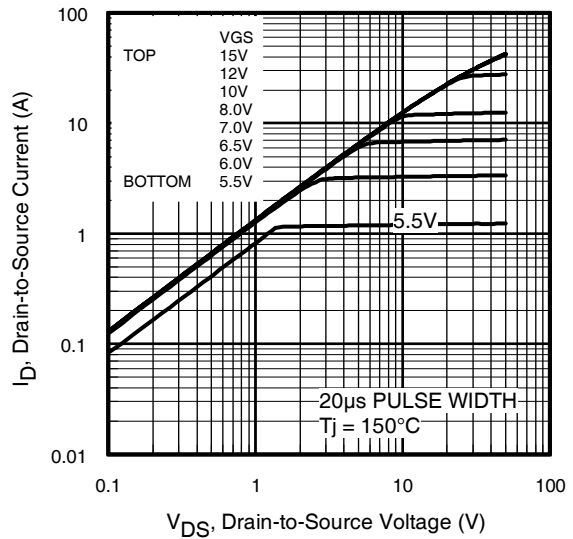
④ Pulse width  $\leq 300\mu s$ ; duty cycle  $\leq 2\%$ .

⑤  $C_{oss \text{ eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .  
 $C_{oss \text{ eff. (ER)}}$  is a fixed capacitance that stores the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

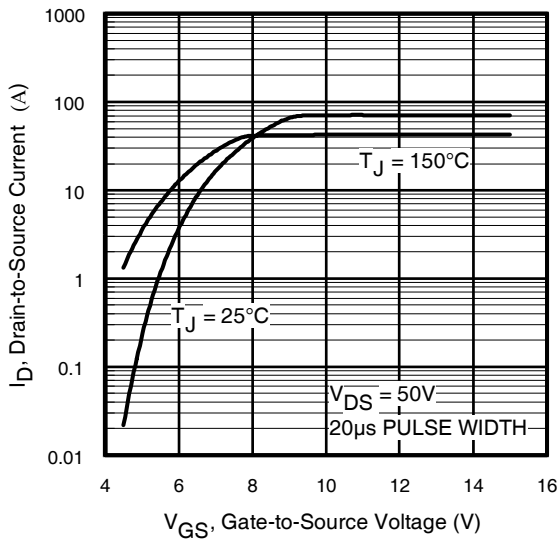
# IRFP21N60LPbF



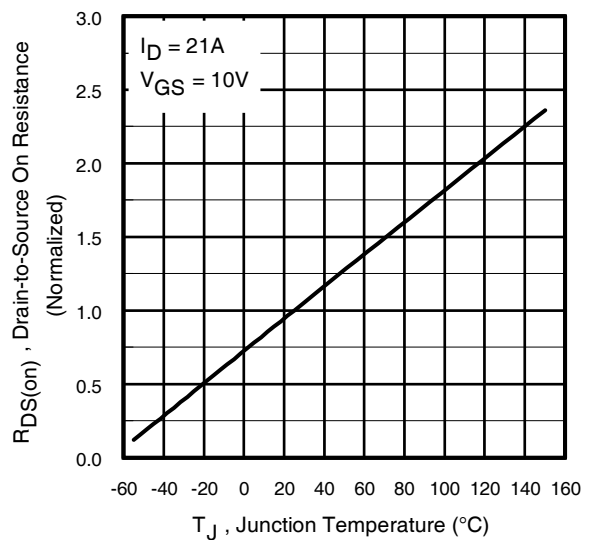
**Fig 1.** Typical Output Characteristics



**Fig 2.** Typical Output Characteristics

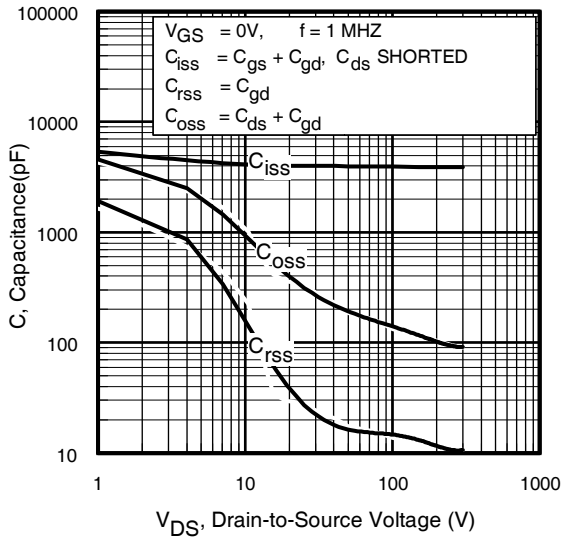


**Fig 3.** Typical Transfer Characteristics

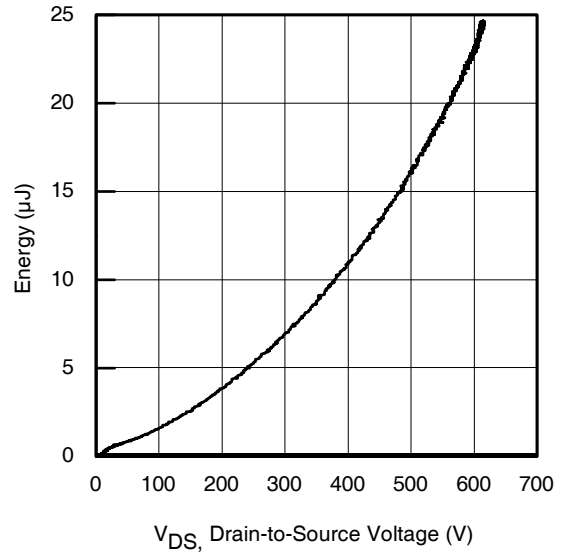


**Fig 4.** Normalized On-Resistance vs. Temperature

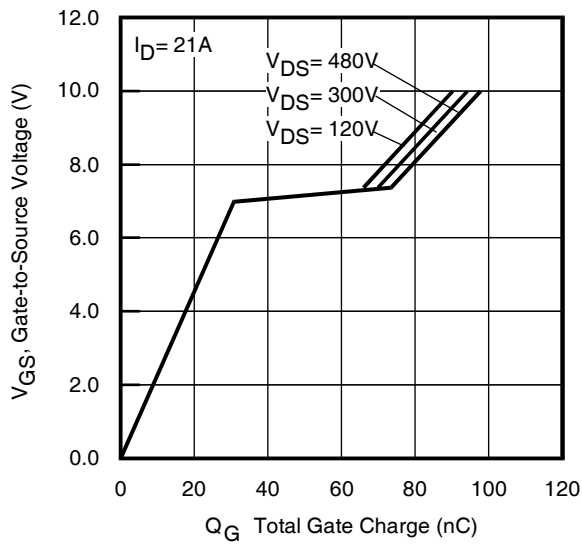
# IRFP21N60LPbF



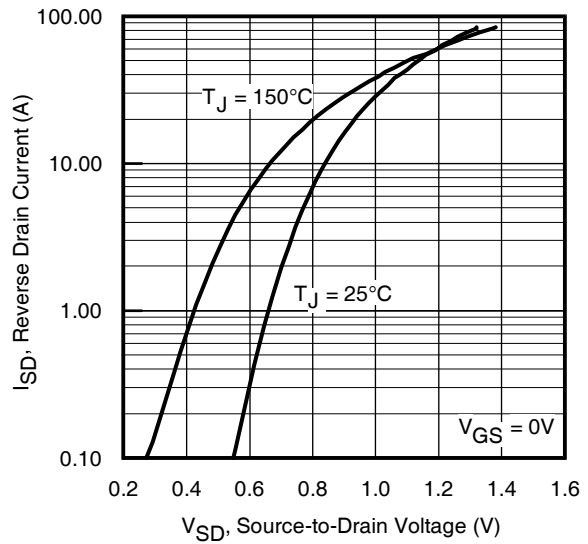
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage



**Fig 6.** Typ. Output Capacitance Stored Energy vs.  $V_{DS}$

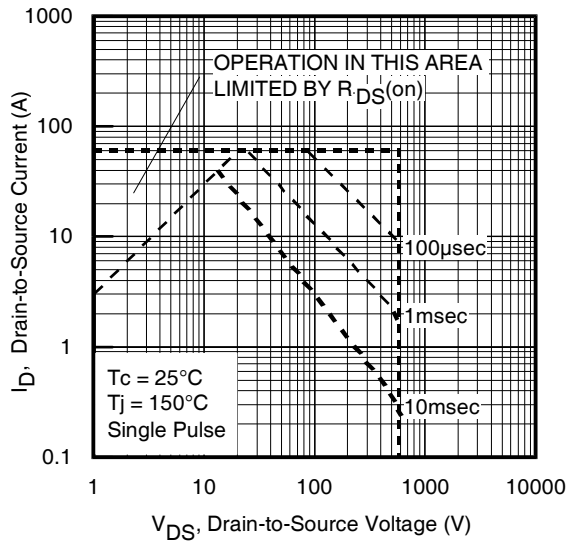


**Fig 7.** Typical Gate Charge vs. Gate-to-Source Voltage

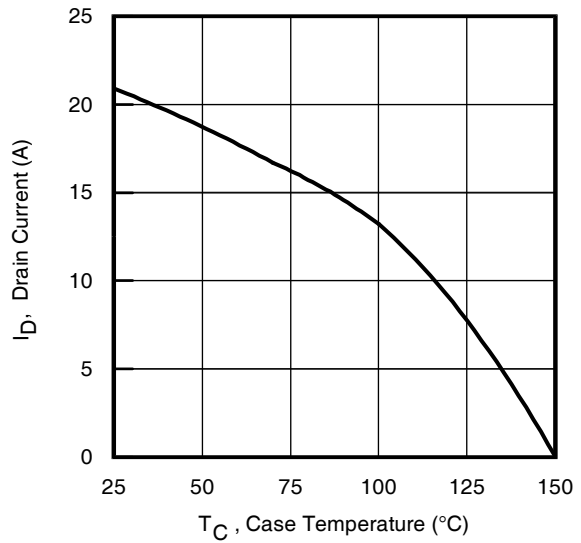


**Fig 8.** Typical Source-Drain Diode Forward Voltage

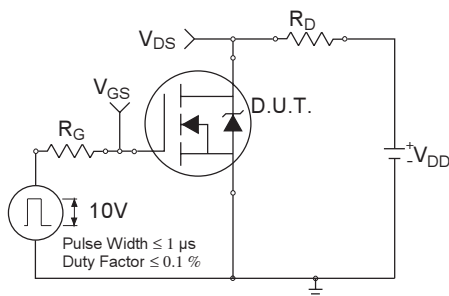
# IRFP21N60LPbF



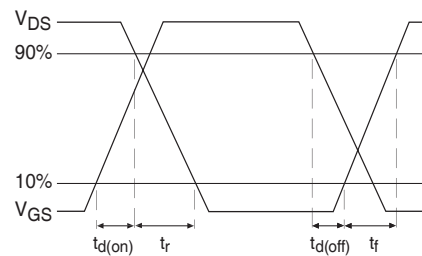
**Fig 9.** Maximum Safe Operating Area



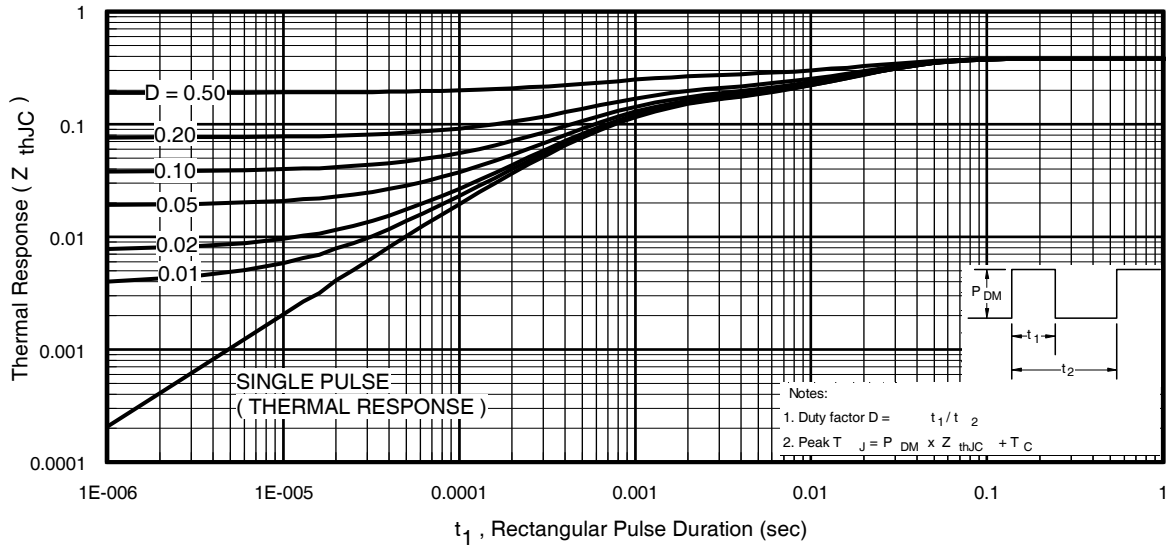
**Fig 10.** Maximum Drain Current vs. Case Temperature



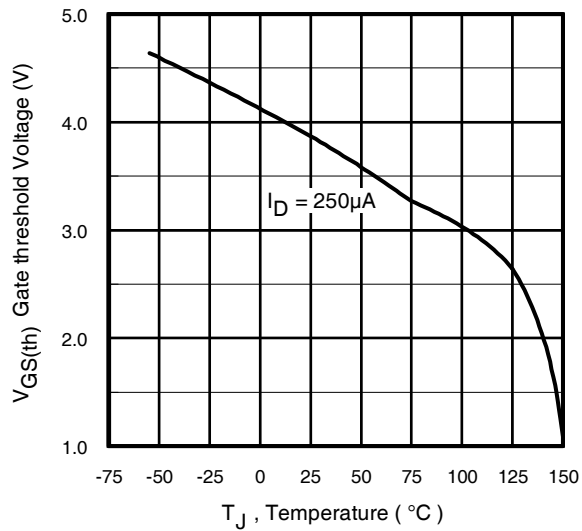
**Fig 11a.** Switching Time Test Circuit



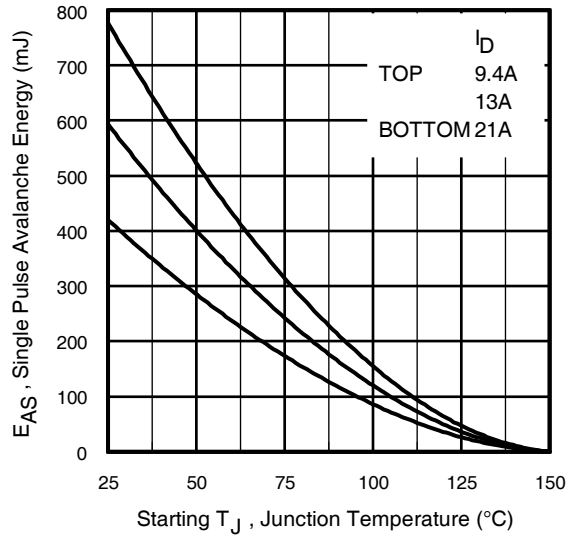
**Fig 11b.** Switching Time Waveforms



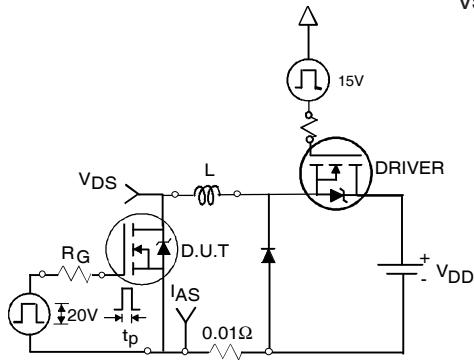
**Fig 12.** Maximum Effective Transient Thermal Impedance, Junction-to-Case



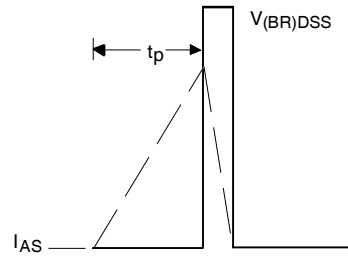
**Fig 13.** Threshold Voltage vs. Temperature



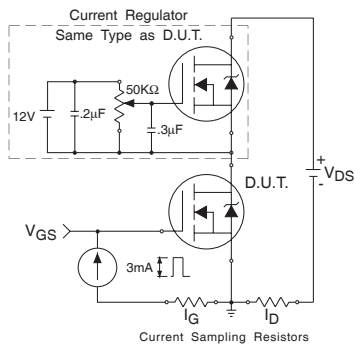
**Fig 14a.** Maximum Avalanche Energy vs. Drain Current



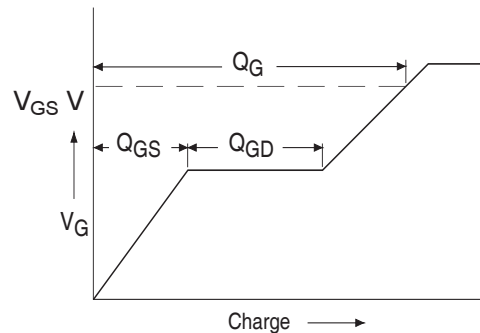
**Fig 14b.** Unclamped Inductive Test Circuit



**Fig 14c.** Unclamped Inductive Waveforms

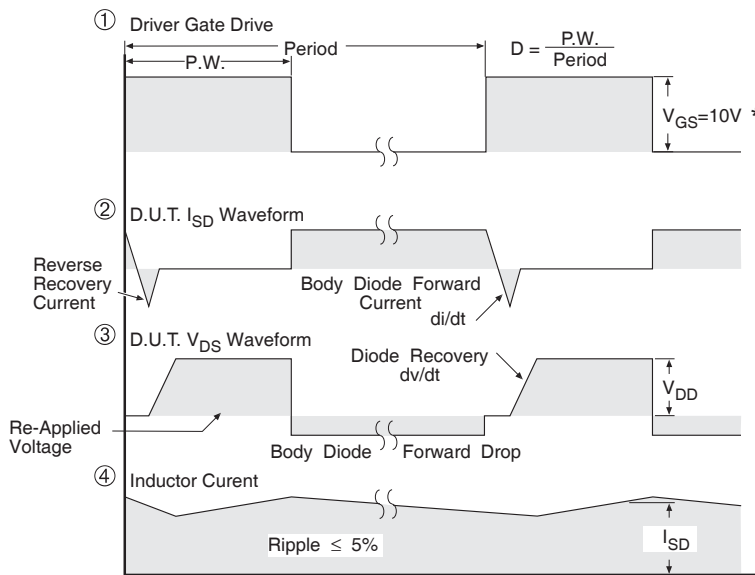
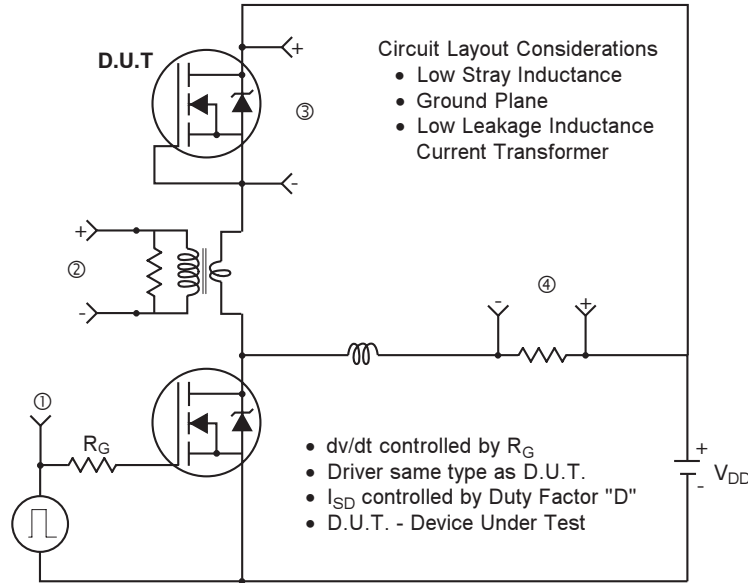


**Fig 15a.** Gate Charge Test Circuit



**Fig 15b.** Basic Gate Charge Waveform

## Peak Diode Recovery dv/dt Test Circuit



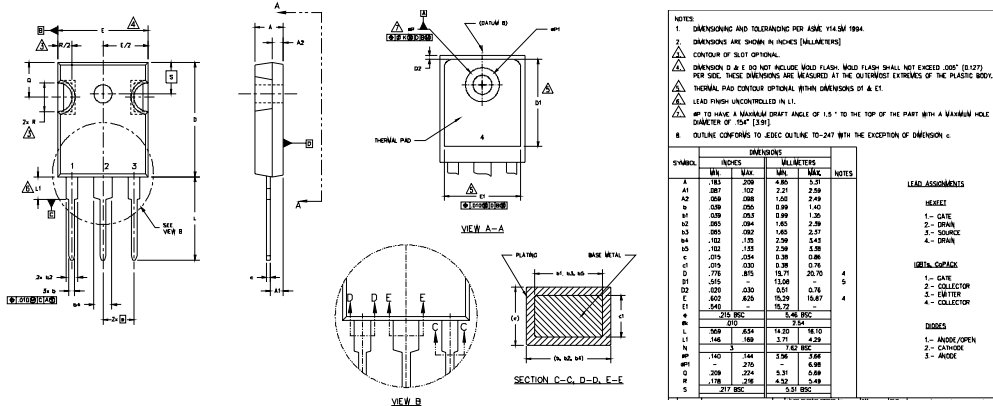
\*  $V_{GS} = 5V$  for Logic Level Devices

**Fig 16.** For N-Channel HEXFET® Power MOSFETs



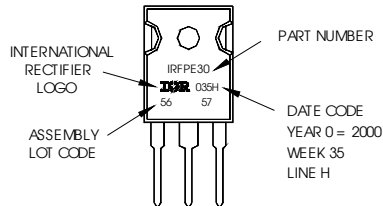
## TO-247AC Package Outline

Dimensions are shown in millimeters (inches)



## TO-247AC Part Marking Information

EXAMPLE: THIS IS AN IRFPE30  
WITH ASSEMBLY  
LOT CODE 5657  
ASSEMBLED ON VW 35, 2000  
IN THE ASSEMBLY LINE "H"  
**Note:** "P" in assembly line  
position indicates "Lead-Free"



**TO-247AC package is not recommended for Surface Mount Application.**

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.