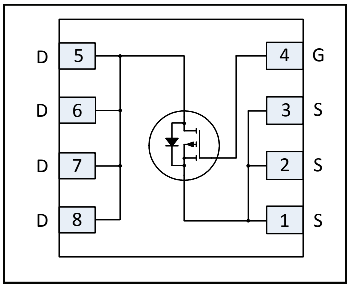
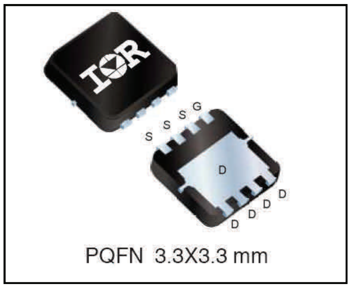
International
IOR Rectifier

IRFHM9391TRPbF

HEXFET® Power MOSFET

V_{DSS}	-30	V
$R_{DS(on)}$ max (@ V_{GS} = -10V)	14.6	mΩ
(@ V_{GS} = -4.5V)	22.5	
Qg (typical)	32	nC
I_D (@T_A = 25°C)	-11	A





PQFN 3.3X3.3 mm

Applications

- System/load switch,
- Charge or discharge switch for battery protection

Features		Benefits
Low Thermal Resistance to PCB (<3.8°C/W)		Enable better Thermal Dissipation
Low Profile (<1.05 mm)	results in	Increased Power Density
Industry-Standard Pinout	⇒	Multi-Vendor Compatibility
Compatible with Existing Surface Mount Techniques		Easier Manufacturing
RoHS Compliant, Halogen-Free		Environmentally Friendlier
MSL1,Consumer Qualification		Increased Reliability

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRFHM9391PbF	PQFN 3.3mm x 3.3mm	Tape and Reel	4000	IRFHM9391TRPbF

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{GS}	Gate-to-Source Voltage	± 25	V
I_D @ T_A = 25°C	Continuous Drain Current, V_{GS} @ 10V	-11	A
I_D @ T_A= 70°C	Continuous Drain Current, V_{GS} @ 10V	-9.0	
I_{DM}	Pulsed Drain Current	-90	
I_D @ $T_{C(Bottom)}$ = 25°C	Continuous Drain Current, V_{GS} @ 10V	-38⑤⑥	
I_D @ $T_{C(Bottom)}$ = 100°C	Continuous Drain Current, V_{GS} @ 10V	-24⑤⑥	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Source Bonding Technology Limited)	-24⑥	
P_D @T_A = 25°C	Power Dissipation ④	2.6	W
P_D @$T_{C(Bottom)}$ = 25°C	Power Dissipation ④	33	
	Linear Derating Factor ④	0.021	W/°C
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 150	°C

Notes ① through ⑥ are on page 9

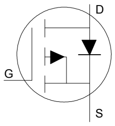
Static @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-30	——	——	V	V_{GS} = 0V, I_D = -250μA
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	——	0.02	——	V/°C	Reference to 25°C, I_D = -1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	——	10	——	mΩ	V_{GS} = -20V, I_D = -11A ②
		——	11.7	14.6		V_{GS} = -10V, I_D = -11A ②
		——	18	22.5		V_{GS} = -4.5V, I_D = -11A ②
$V_{GS(th)}$	Gate Threshold Voltage	-1.3	-1.8	-2.4	V	V_{DS} = V_{GS}, I_D = -25μA
$\Delta V_{GS(th)}$	Gate Threshold Voltage Coefficient	——	-5.1	——	mV/°C	
I_{DSS}	Drain-to-Source Leakage Current	——	——	-1.0	μA	V_{DS} = -24V, V_{GS} = 0V
		——	——	-150		V_{DS} = -24V, V_{GS} = 0V,T_J = 125°C
I_{GSS}	Gate-to-Source Forward Leakage	——	——	-10	μA	V_{GS} = -25V
	Gate-to-Source Reverse Leakage	——	——	10		V_{GS} = 25V
gfs	Forward Transconductance	16	——	——	S	V_{DS} = -10V, I_D = -9.0A
Q_g	Total Gate Charge	——	16	——	nC	V_{GS} = -4.5V, V_{DS} =-15V, I_D = -9.0A
Q_g	Total Gate Charge	——	32	48	nC	V_{DS} = -15V V_{GS} = -10V I_D = -9.0A
Q_{gs1}	Pre-Vth Gate-to-Source Charge	——	3.0	——		
Q_{gs2}	Post-Vth Gate-to-Source Charge	——	1.4	——		
Q_{gd}	Gate-to-Drain Charge	——	8.0	——		
Q_{godr}	Gate Charge Overdrive	——	19.6	——		
Q_{sw}	Switch Charge (Q_{gs2} + Q_{gd})	——	9.4	——		
Q_{oss}	Output Charge	——	9.0	——	nC	V_{DS} = -16V, V_{GS} = 0V
R_G	Gate Resistance	——	16	——	Ω	
$t_{d(on)}$	Turn-On Delay Time	——	11	——	ns	V_{DD} = -15V, V_{GS} = -4.5V② I_D = -1.0A R_G=6.8Ω
t_r	Rise Time	——	27	——		
$t_{d(off)}$	Turn-Off Delay Time	——	72	——		
t_f	Fall Time	——	60	——		
C_{iss}	Input Capacitance	——	1543	——	pF	V_{GS} = 0V V_{DS} = -25V ƒ = 1.0KHz
C_{oss}	Output Capacitance	——	310	——		
C_{rss}	Reverse Transfer Capacitance	——	208	——		

Avalanche Characteristics

	Parameter	Typ.	Max.	Units
E_{AS}	Single Pulse Avalanche Energy ①	——	75	mJ

Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	——	——	-2.8	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	——	——	-90		
V_{SD}	Diode Forward Voltage	——	——	-1.2	V	T_J = 25°C, I_S = -2.8A, V_{GS} = 0V ②
t_{rr}	Reverse Recovery Time	——	64	96	ns	T_J = 25°C, I_F = -2.8A, V_{DD} = -24V di/dt = 100A/μs ②
Q_{rr}	Reverse Recovery Charge	——	25	38	nC	

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$ (Bottom)	Junction-to-Case ③	——	3.8	°C/W
$R_{\theta JC}$ (Top)	Junction-to-Case ③	——	42	
$R_{\theta JA}$	Junction-to-Ambient ④	——	47	
$R_{\theta JA}$ (<10s)	Junction-to-Ambient ④	——	32	

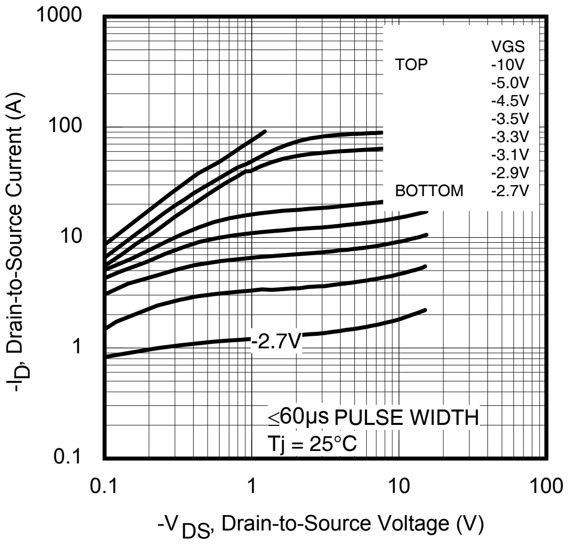


Fig 1. Typical Output Characteristics

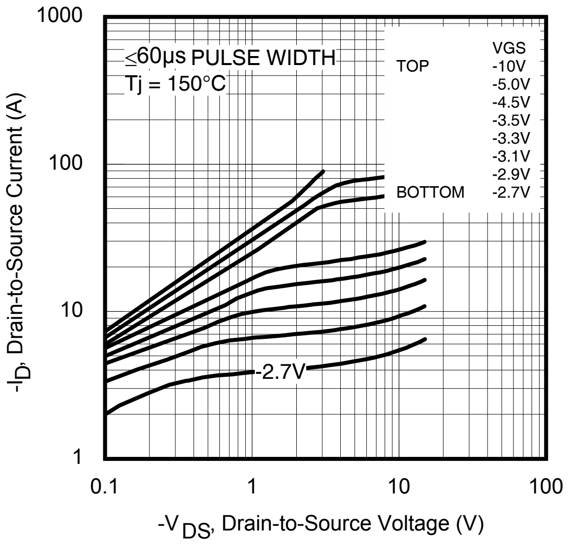


Fig 2. Typical Output Characteristics

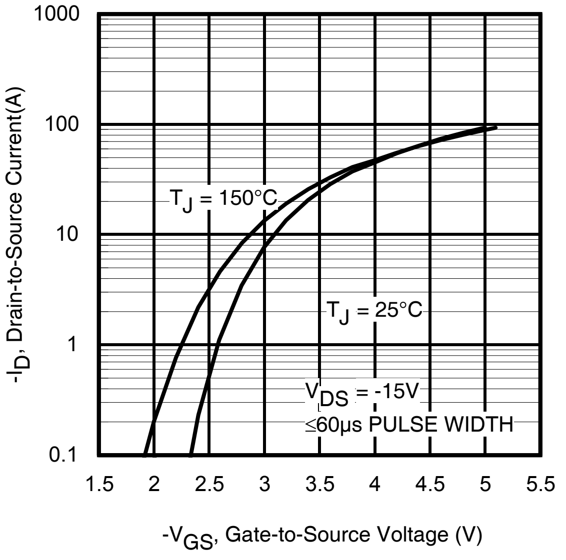


Fig 3. Typical Transfer Characteristics

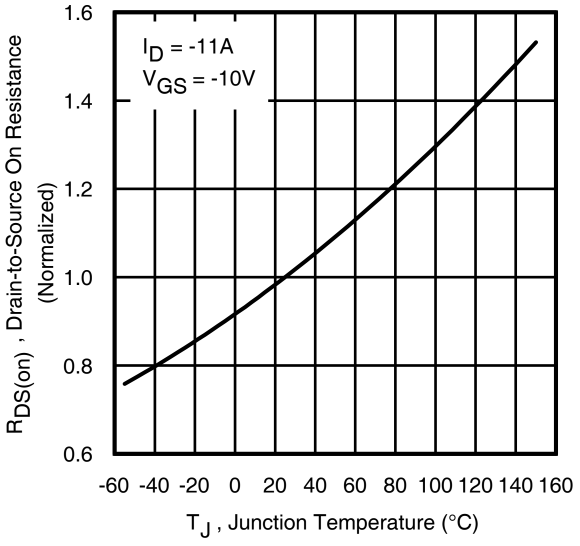


Fig 4. Normalized On-Resistance vs. Temperature

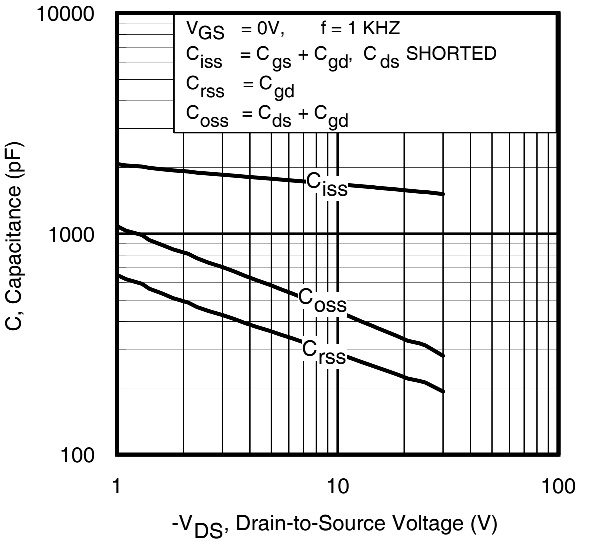


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

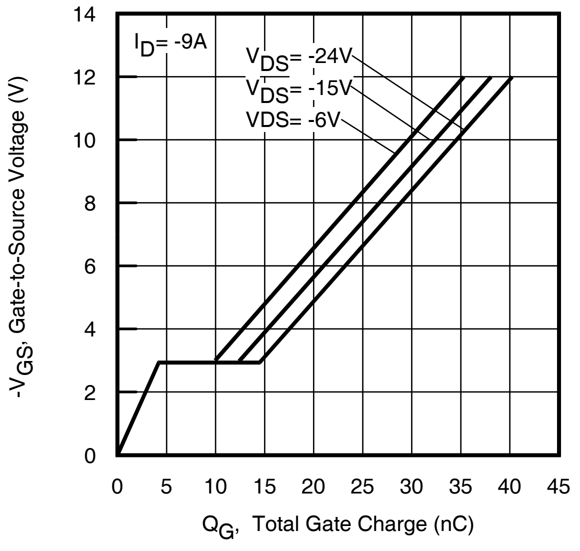


Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage

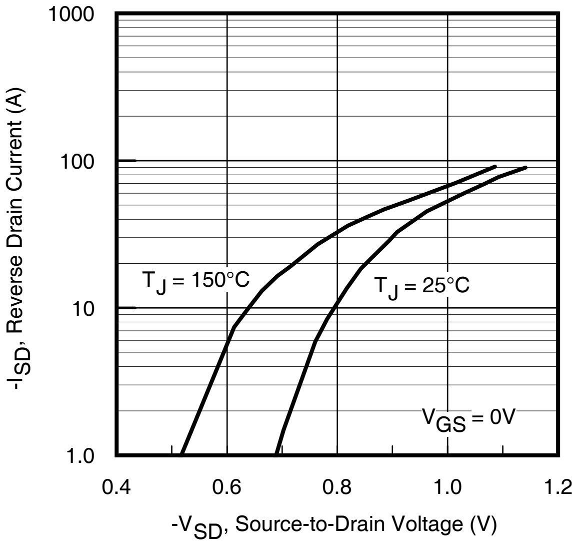


Fig 7. Typical Source-Drain Diode Forward Voltage

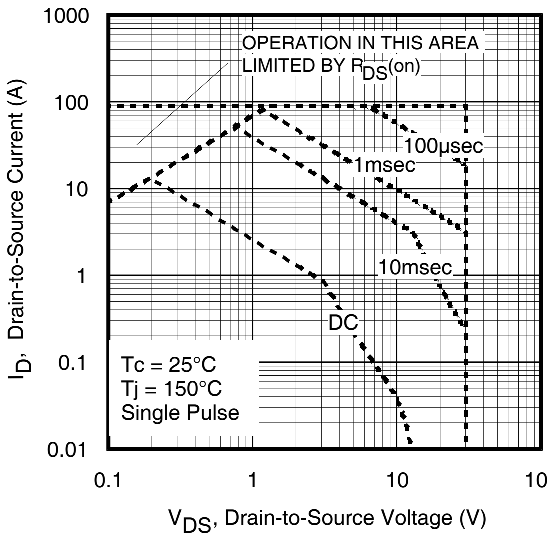


Fig 8. Maximum Safe Operating Area

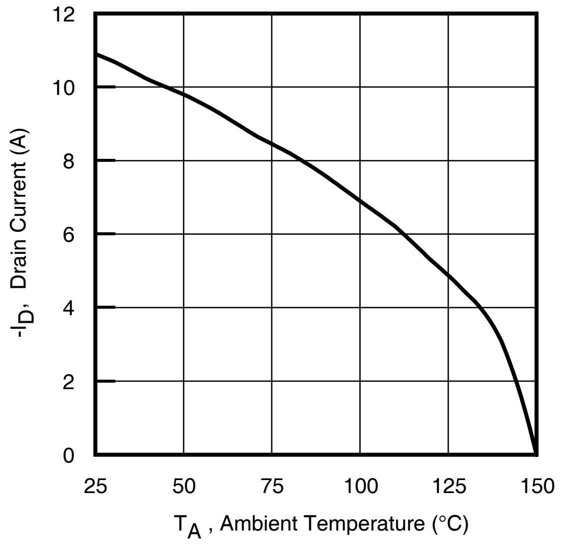


Fig 9. Maximum Drain Current vs. Case Temperature

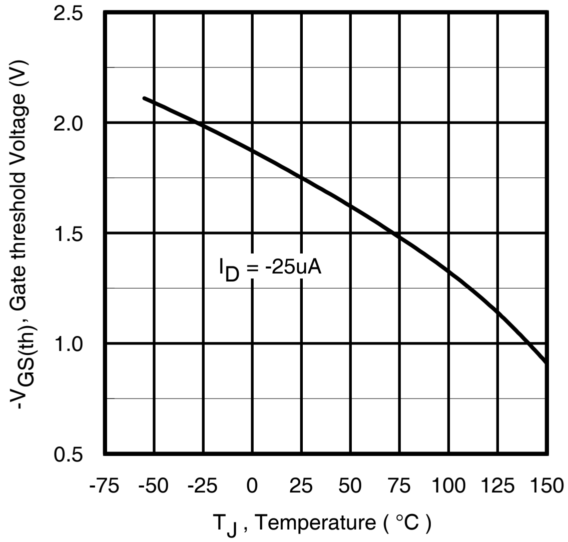


Fig 10. Threshold Voltage Vs. Temperature

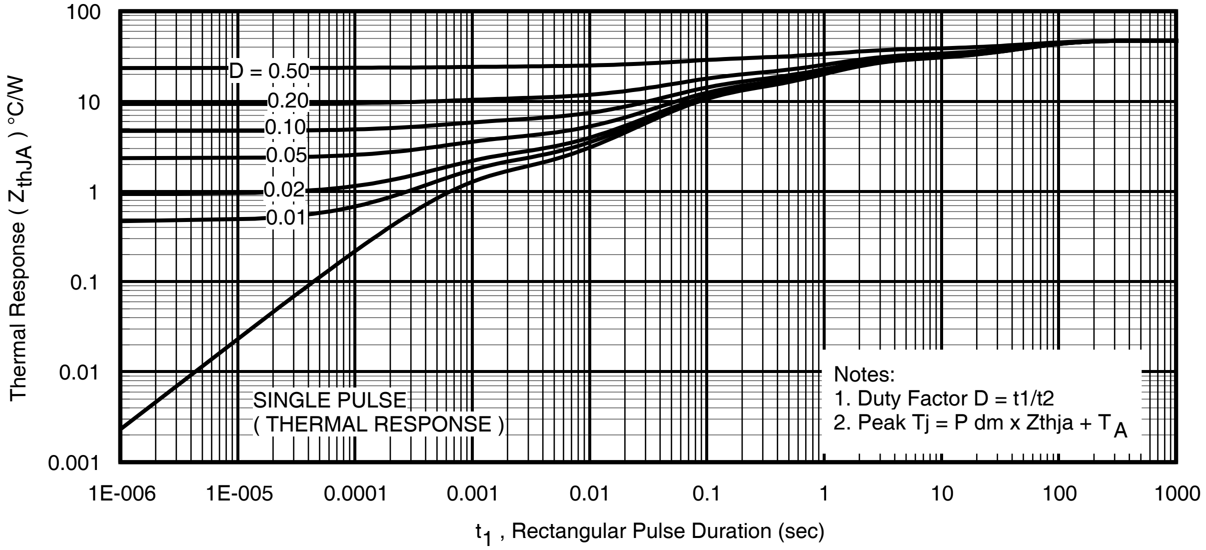


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

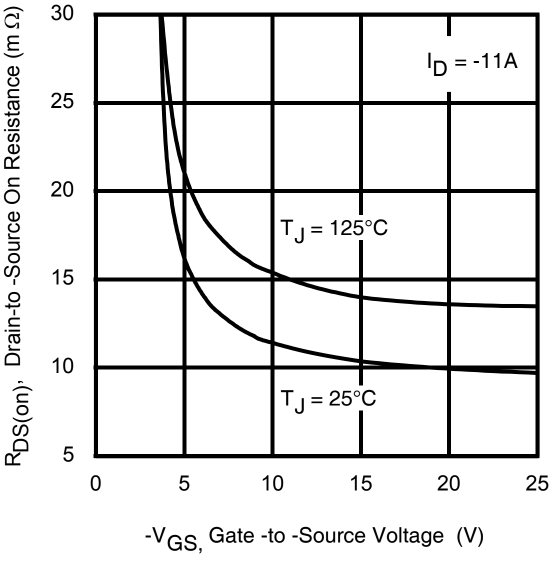


Fig 12. On– Resistance vs. Gate Voltage

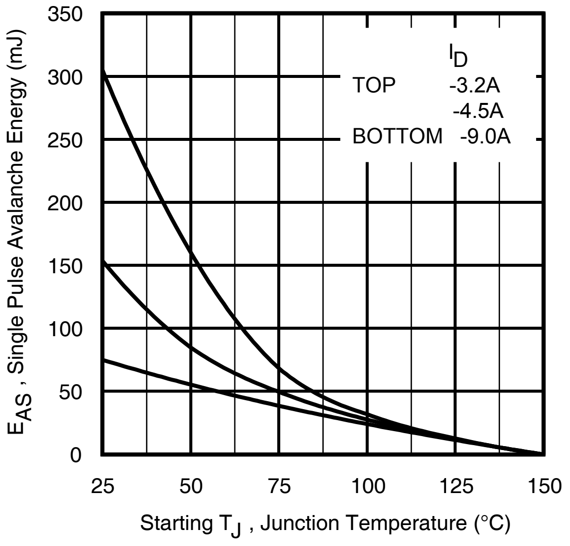
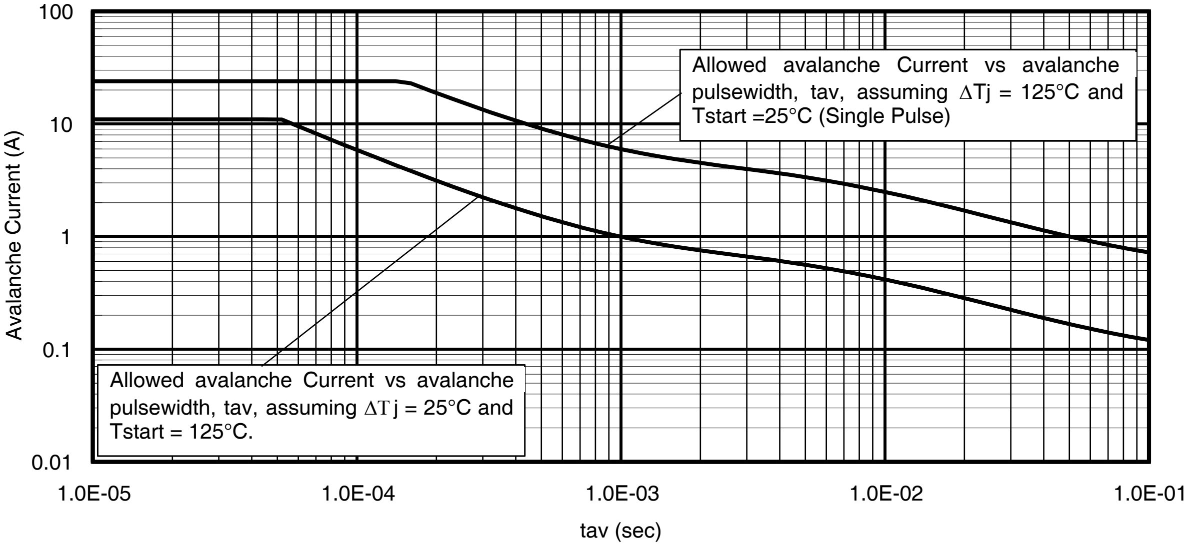


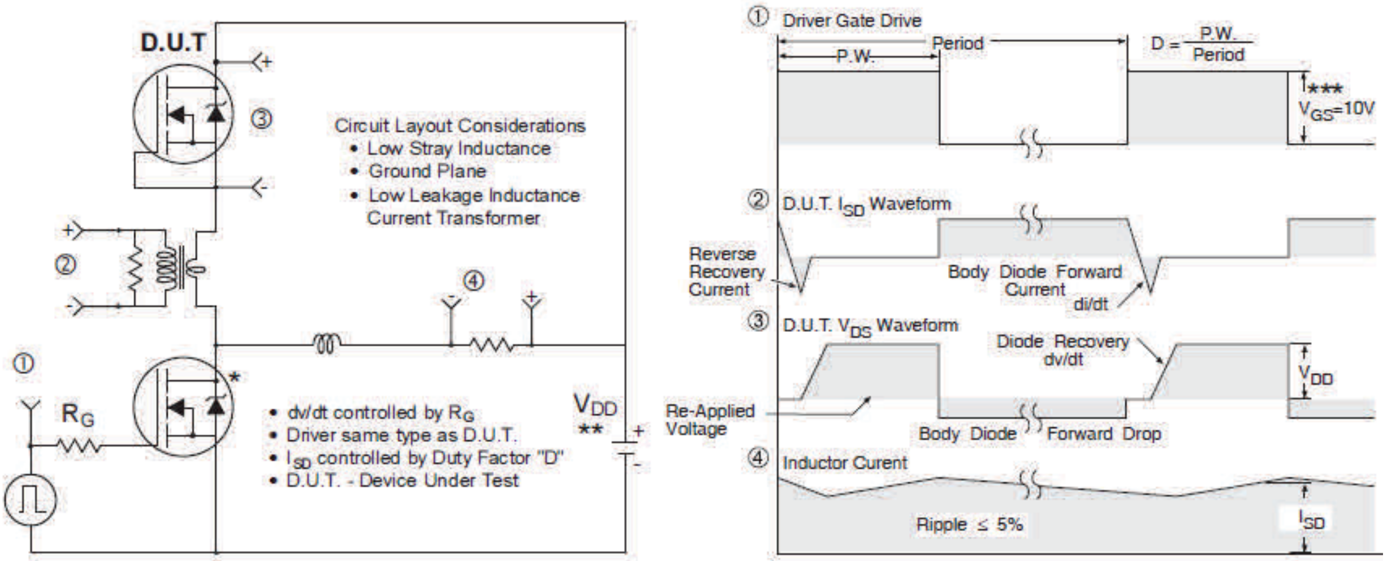
Fig 13. Maximum Avalanche Energy vs. Drain Current



Allowed avalanche Current vs avalanche pulsewidth, tav, assuming ΔTj = 125°C and Tstart =25°C (Single Pulse)

Allowed avalanche Current vs avalanche pulsewidth, tav, assuming ΔTj = 25°C and Tstart = 125°C.

Fig 14. Typical Avalanche Current vs. Pulsewidth



* Use P-Channel Driver for P-Channel Measurements

** Reverse Polarity for P-Channel

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

Fig 15. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

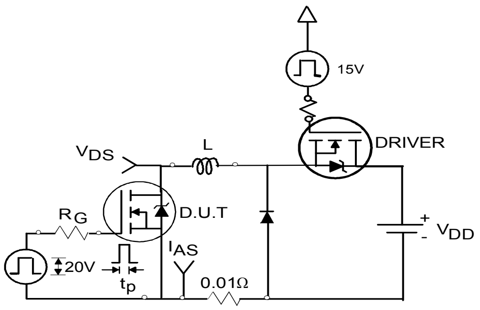


Fig 16a. Unclamped Inductive Test Circuit

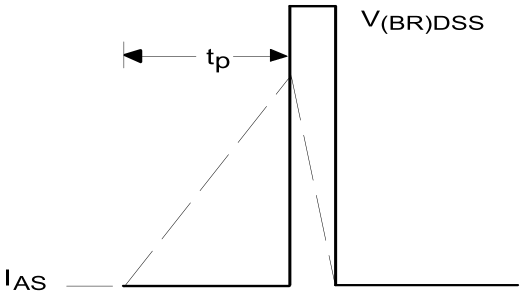


Fig 16b. Unclamped Inductive Waveforms

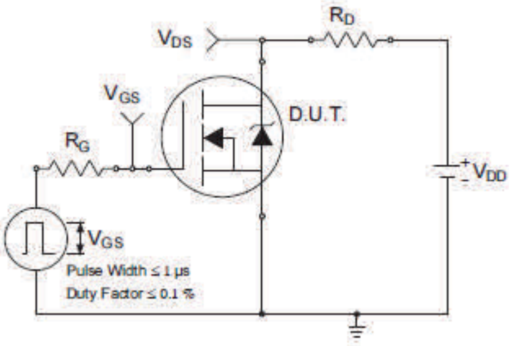


Fig 17a. Switching Time Test Circuit

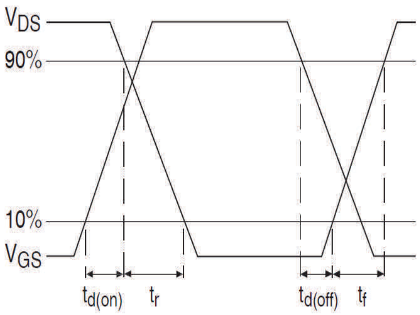


Fig 17b. Switching Time Waveforms

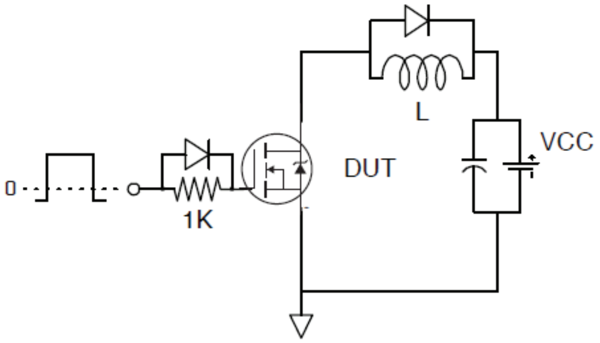


Fig 18. Gate Charge Test Circuit

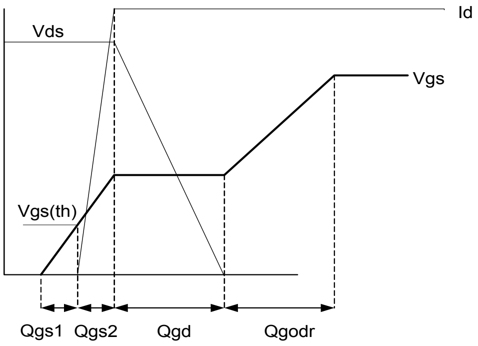
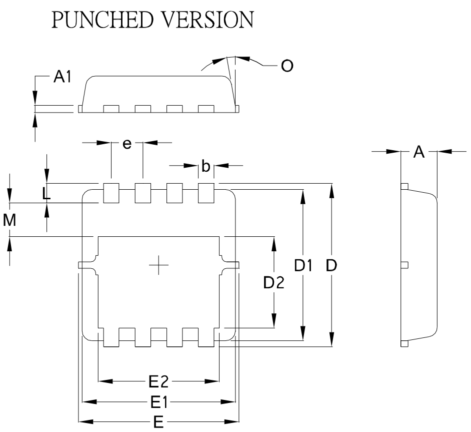


Fig 19. Gate Charge Waveform

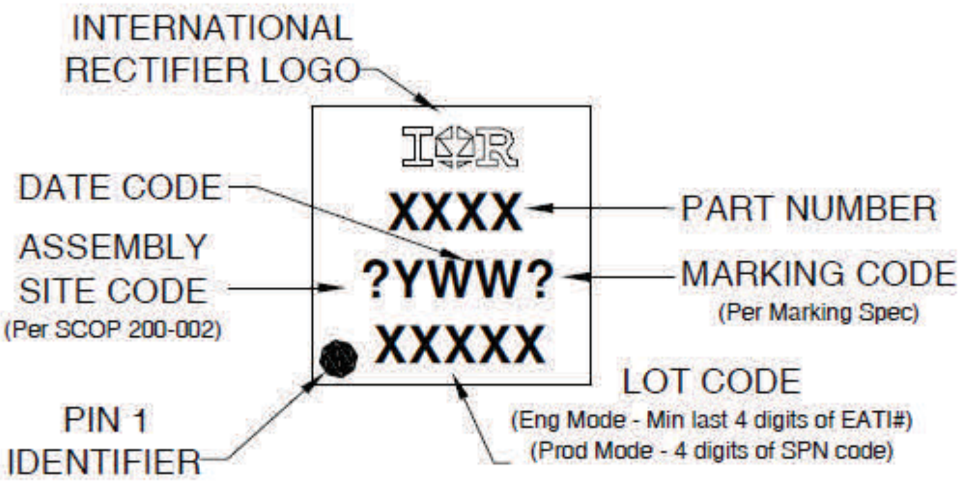
PQFN 3.3 x 3.3 Package Details



SYMBOL	COMMON			
	MM		INCH	
	MIN.	MAX.	MIN.	MAX.
A	0.70	1.05	0.0276	0.0413
A1	0.12	0.39	0.0047	0.0154
b	0.25	0.39	0.0098	0.0154
D	3.20	3.45	0.1260	0.1358
D1	3.00	3.20	0.1181	0.1417
D2	1.69	2.20	0.0665	0.0866
E	3.20	3.40	0.1260	0.1339
E1	3.00	3.20	0.1181	0.1417
E2	2.15	2.59	0.0846	0.1020
e	0.65 BSC		0.0256 BSC	
L	0.15	0.55	0.0059	0.0217
M	0.59	——	0.0232	——
O	9Deg	12Deg	9Deg	12Deg

For more information on board mounting, including footprint and stencil recommendation, please refer to application note AN-1136: http://www.irf.com/technical-info/appnotes/an-1136.pdf
For more information on package inspection techniques, please refer to application note AN-1154: http://www.irf.com/technical-info/appnotes/an-1154.pdf

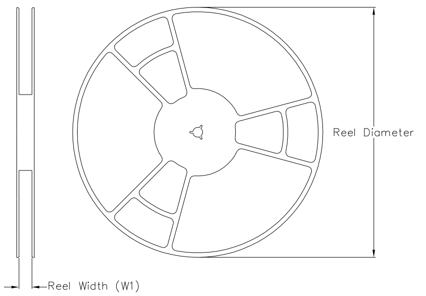
PQFN 3.3 x 3.3 Part Marking



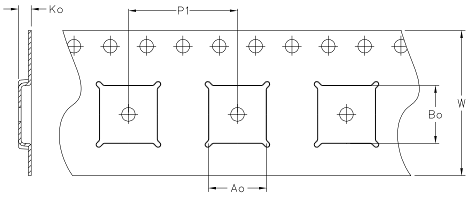
Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

PQFN 3.3 x 3.3 Tape and Reel

REEL DIMENSIONS

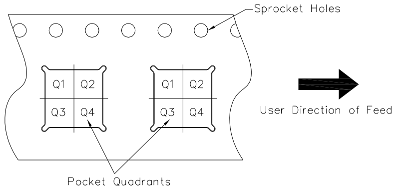


TAPE DIMENSIONS



CODE	DIMENSION (MM)		DIMENSION (INCH)	
	MIN	MAX	MIN	MAX
Ao	3.50	3.70	.138	.146
Bo	3.50	3.70	.138	.146
Ko	1.10	1.30	.043	.051
P_1	7.90	8.10	.311	.319
W	11.80	12.20	.465	.480
W_1	12.30	12.50	.484	.492
Qty	4000			
Reel Diameter	13 Inches			

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



CODE	DESCRIPTION
Ao	Dimension design to accommodate the component width
Bo	Dimension design to accommodate the component lenght
Ko	Dimension design to accommodate the component thickness
W	Overall width of the carrier tape
P_1	Pitch between successive cavity centers

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

Qualification Information†

Qualification Level	Consumer†† (per JEDEC JESD47F guidelines)	
Moisture Sensitivity Level	PQFN 3.3mm x 3.3mm	MSL1 (per JEDEC J-STD-020D††)
RoHS Compliant	Yes	

† Qualification standards can be found at International Rectifier's web site: http://www.irf.com/product-info/reliability/

†† Applicable version of JEDEC standard at the time of product release.

Notes:

① Starting T_J = 25°C, L = 1.872mH, R_G = 50Ω, I_{AS} = -9A.

② Pulse width ≤ 400µs; duty cycle ≤ 2%.

③ R_θ is measured at TJ of approximately 90°C.

④ When mounted on 1 inch square PCB (FR-4). Please refer to AN-994 for more details: http://www.irf.com/technical-info/appnotes/an-994.pdf

⑤ Calculated continuous current based on maximum allowable junction temperature.

⑥ Current is limited by source bonding technology.

Revision History

Date	Comments
7/1/14	• Remove "SAWN" package outline on page 7. • Updated part marking on page 7. • Updated tape and reel on page 8.

International
IOR Rectifier

IR WORLD HEADQUARTERS: 101 N. Sepulveda Blvd., El Segundo, California 90245, USA
To contact International Rectifier, please visit http://www.irf.com/whoto-call/