International
IOR Rectifier

IRF6648PbF
IRF6648TRPbF

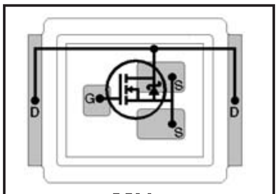
DirectFET™ Power MOSFET ②

- RoHs Compliant ①
- Lead-Free (Qualified up to 260°C Reflow)
- Application Specific MOSFETs
- Optimized for Synchronous Rectification for 5V to 12V outputs
- Low Conduction Losses
- Ideal for 24V input Primary Side Forward Converters
- Low Profile (<0.7mm)
- Dual Sided Cooling Compatible ①
- Compatible with existing Surface Mount Techniques ①

Typical values (unless otherwise specified)

V_{DSS}	V_{GS}	$R_{DS(on)}$
60V max	±20V max	5.5mΩ@ 10V

$Q_{g\ tot}$	Q_{gd}	Q_{gs2}	Q_{rr}	Q_{oss}	$V_{gs(th)}$
36nC	14nC	2.7nC	37nC	21nC	4.0V



MN

DirectFET™ ISOMETRIC

Applicable DirectFET Outline and Substrate Outline (see p.7,8 for details)①

SH	SJ	SP		MZ	MN				

Description

The IRF6648PbF combines the latest HEXFET® Power MOSFET Silicon technology with the advanced DirectFET™ packaging to achieve the lowest on-state resistance in a package that has the footprint of a SO-8 and only 0.7 mm profile. The DirectFET package is compatible with existing layout geometries used in power applications, PCB assembly equipment and vapor phase, infra-red or convection soldering techniques. Application note AN-1035 is followed regarding the manufacturing methods and processes. The DirectFET package allows dual sided cooling to maximize thermal transfer in power systems, improving previous best thermal resistance by 80%.

The IRF6648PbF is an optimized switch for use in synchronous rectification circuits with 5-12Vout, and is also ideal for use as a primary side switch in 24Vin forward converters. The reduced total losses in the device coupled with the high level of thermal performance enables high efficiency and low temperatures, which are key for system reliability improvements, and makes this device ideal for high performance.

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{DS}	Drain-to-Source Voltage	60	V
V_{GS}	Gate-to-Source Voltage	±20	
I_D @ $T_C = 25°C$	Continuous Drain Current, V_{GS} @ 10V ④	86	A
I_D @ $T_C = 70°C$	Continuous Drain Current, V_{GS} @ 10V ④	69	
I_{DM}	Pulsed Drain Current ⑤	260	
E_{AS}	Single Pulse Avalanche Energy ⑥	47	mJ
I_{AR}	Avalanche Current ⑤	34	A

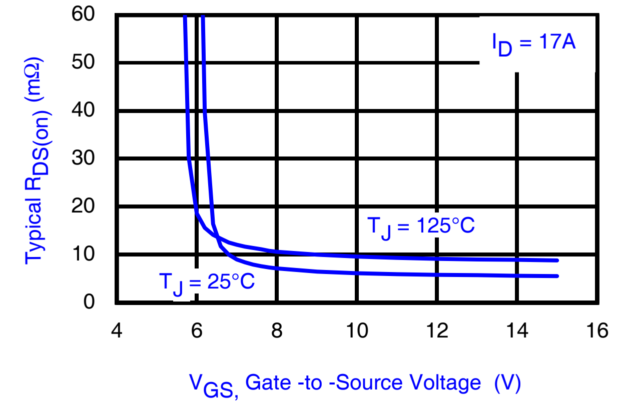


Fig 1. Typical On-Resistance vs. Gate-to-Source Voltage

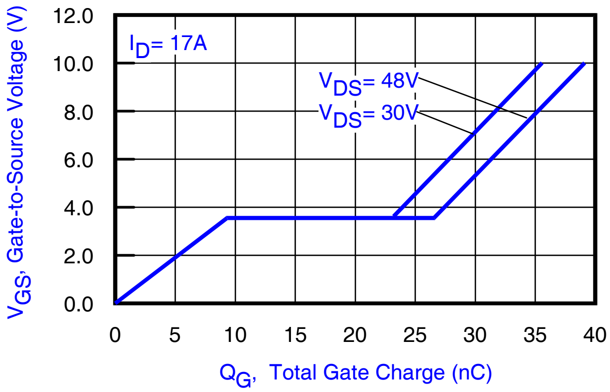


Fig 2. Total Gate Charge vs. Gate-to-Source Voltage

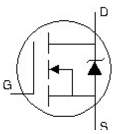
Notes:

① Click on this section to link to the appropriate technical paper.
② Click on this section to link to the DirectFET Website.
③ Surface mounted on 1 in. square Cu board, steady state.
④ T_C measured with thermocouple mounted to top (Drain) of part.
⑤ Repetitive rating; pulse width limited by max. junction temperature.
⑥ Starting $T_J = 25°C$, L = 0.082mH, $R_G = 25Ω$, $I_{AS} = 34A$.

Electrical Characteristic @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	—	—	V	V_{GS} = 0V, I_D = 250μA
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.076	—	V/°C	Reference to 25°C, I_D = 1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	5.5	7.0	mΩ	V_{GS} = 10V, I_D = 17A ⑦
$V_{GS(th)}$	Gate Threshold Voltage	3.0	4.0	4.9	V	V_{DS} = V_{GS}, I_D = 150μA
$\Delta V_{GS(th)}/\Delta T_J$	Gate Threshold Voltage Coefficient	—	-11	—	mV/°C	
I_{DSS}	Drain-to-Source Leakage Current	—	—	20	μA	V_{DS} = 60V, V_{GS} = 0V
		—	—	250		V_{DS} = 48V, V_{GS} = 0V, T_J = 125°C
I_{GSS}	Gate-to-Source Forward Leakage	—	—	100	nA	V_{GS} = 20V
	Gate-to-Source Reverse Leakage	—	—	-100		V_{GS} = -20V
gfs	Forward Transconductance	31	—	—	S	V_{DS} = 10V, I_D = 17A
Q_g	Total Gate Charge	—	36	50	nC	
Q_{gs1}	Pre-Vth Gate-to-Source Charge	—	7.5	—		V_{DS} = 30V
Q_{gs2}	Post-Vth Gate-to-Source Charge	—	2.7	—		V_{GS} = 10V
Q_{gd}	Gate-to-Drain Charge	—	14	21		I_D = 17A
Q_{godr}	Gate Charge Overdrive	—	12	—		See Fig. 15
Q_{sw}	Switch Charge (Q_{gs2} + Q_{gd})	—	17	—		
Q_{oss}	Output Charge	—	21	—	nC	V_{DS} = 16V, V_{GS} = 0V
$R_{G\ (Internal)}$	Gate Resistance	—	1.0	—	Ω	
$t_{d(on)}$	Turn-On Delay Time	—	16	—	ns	V_{DD} = 30V, V_{GS} = 10V ⑦
t_r	Rise Time	—	29	—		I_D = 17A
$t_{d(off)}$	Turn-Off Delay Time	—	28	—		R_G= 6.2Ω
t_f	Fall Time	—	13	—		See Fig. 16 & 17
C_{iss}	Input Capacitance	—	2120	—	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	—	600	—		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	—	170	—		f = 1.0MHz
C_{oss}	Output Capacitance	—	2450	—		V_{GS} = 0V, V_{DS} = 1.0V, f=1.0MHz
C_{oss}	Output Capacitance	—	440	—		V_{GS} = 0V, V_{DS} = 48V, f=1.0MHz

Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	—	—	81	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ⑤	—	—	260		
V_{SD}	Diode Forward Voltage	—	—	1.3	V	T_J = 25°C, I_S = 17A, V_{GS} = 0V ⑦
t_{rr}	Reverse Recovery Time	—	31	47	ns	T_J = 25°C, I_F = 17A, V_{DD} = 30V
Q_{rr}	Reverse Recovery Charge	—	37	56	nC	di/dt = 100A/μs ⑦ See Fig. 18

Notes:

⑤ Repetitive rating; pulse width limited by max. junction temperature.

⑦ Pulse width ≤ 400μs; duty cycle ≤ 2%.

Absolute Maximum Ratings

	Parameter	Max.	Units
P_D @T_A = 25°C	Power Dissipation ③	2.8	W
P_D @T_A = 70°C	Power Dissipation ③	1.8	
P_D @T_C = 25°C	Power Dissipation ④	89	
T_P	Peak Soldering Temperature	270	°C
T_J T_{STG}	Operating Junction and Storage Temperature Range	-40 to + 150	

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient ③⓫	——	45	°C/W
$R_{\theta JA}$	Junction-to-Ambient ⑨⓫	12.5	——	
$R_{\theta JC}$	Junction-to-Case ④⓫	——	1.4	
$R_{\theta J\text{-}PCB}$	Junction-to-PCB Mounted	1.0	——	
	Linear Derating Factor ③	0.022		W/°C

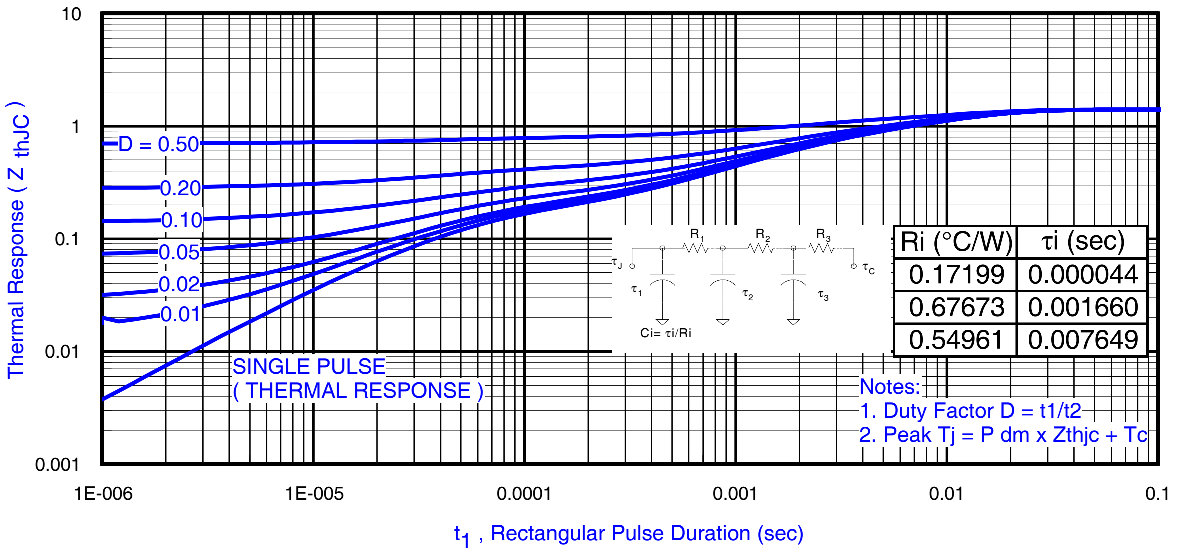


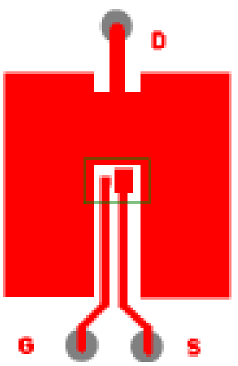
Fig 3. Maximum Effective Transient Thermal Impedance, Junction-to-Case

Notes:

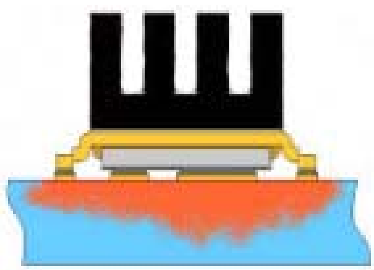
⑨ Used double sided cooling , mounting pad.

⑩ Mounted on minimum footprint full size board with metalized back and with small clip heatsink.

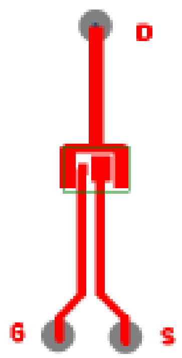
⓫ R_θ is measured at T_J of approximately 90°C.



③ Surface mounted on 1 in. square Cu (still air).



⑨ Mounted to a PCB with small clip heatsink (still air)



⑩ Mounted on minimum footprint full size board with metalized back and with small clip heatsink (still air)

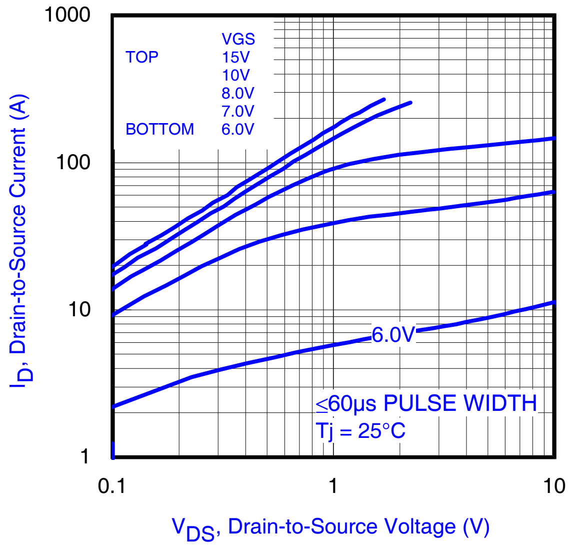


Fig 4. Typical Output Characteristics

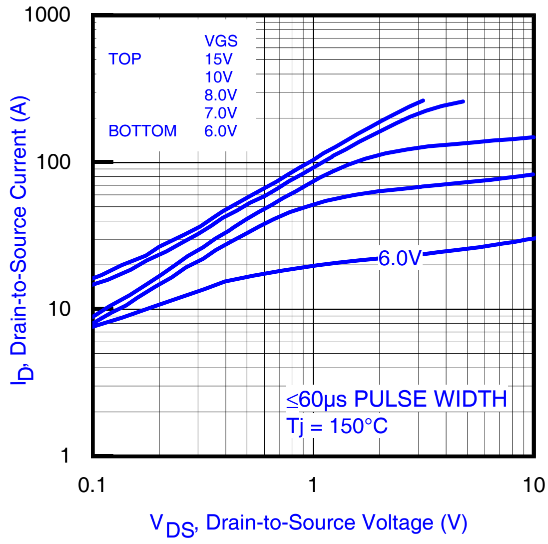


Fig 5. Typical Output Characteristics

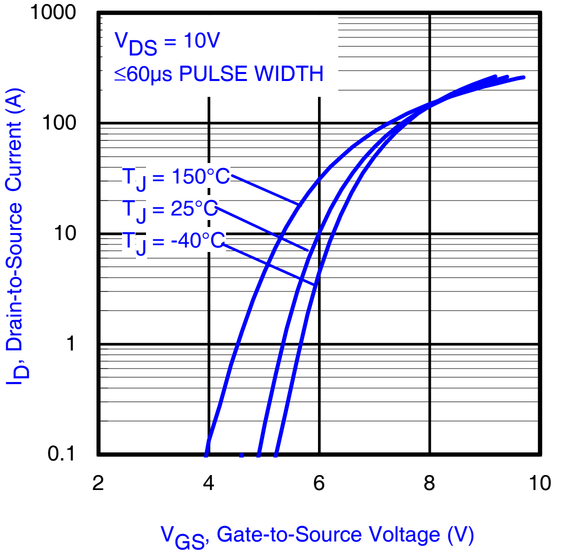


Fig 6. Typical Transfer Characteristics

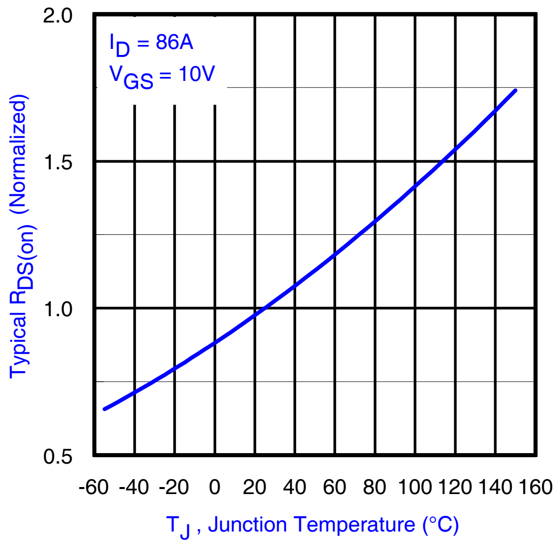


Fig 7. Normalized On-Resistance vs. Temperature

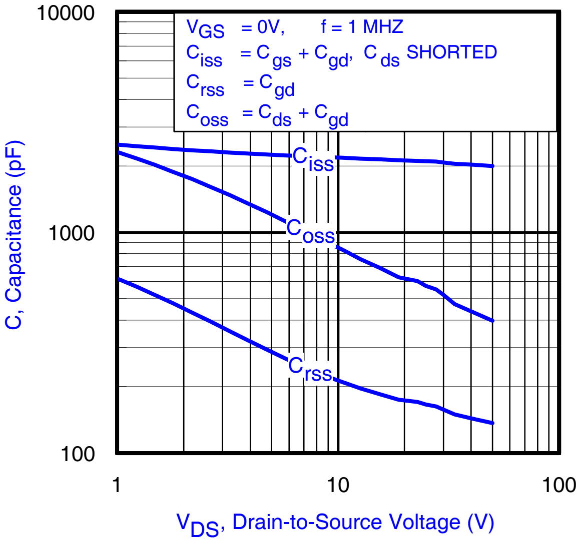


Fig 8. Typical Capacitance vs.Drain-to-Source Voltage

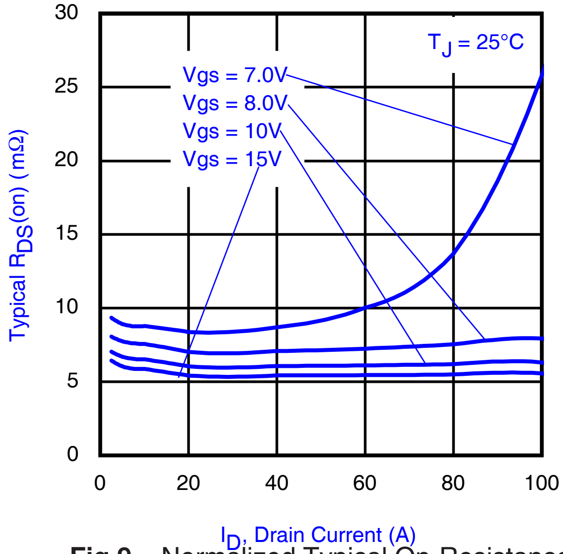


Fig 9. Normalized Typical On-Resistance vs. Drain Current and Gate Voltage

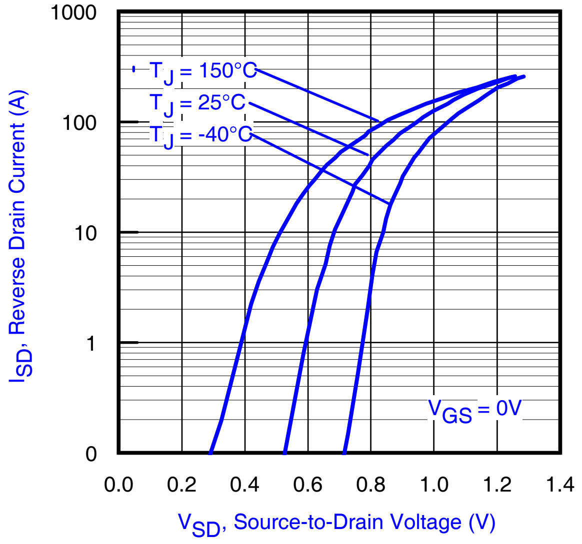


Fig 10. Typical Source-Drain Diode Forward Voltage

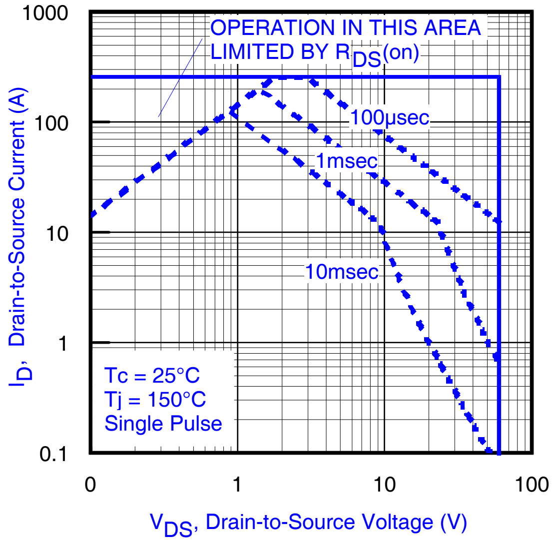


Fig11. Maximum Safe Operating Area

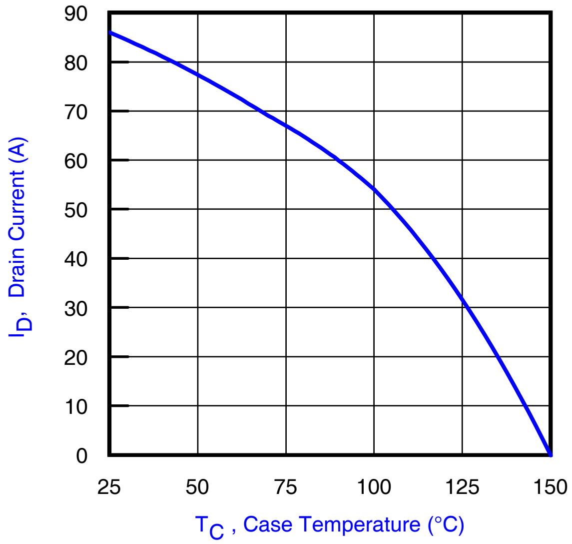


Fig 12. Maximum Drain Current vs. Case Temperature

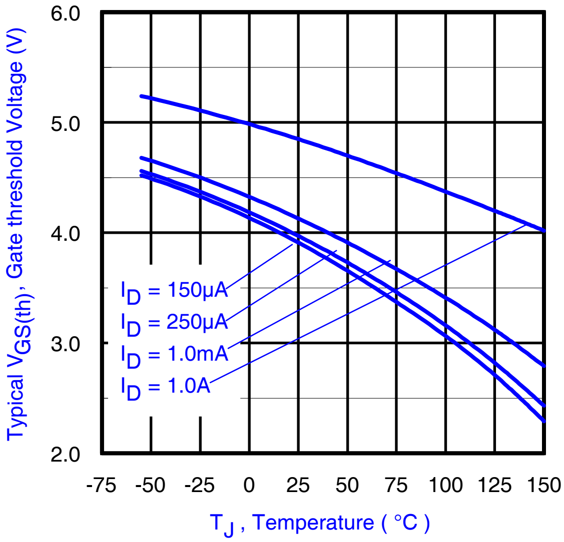


Fig 13. Threshold Voltage vs. Temperature

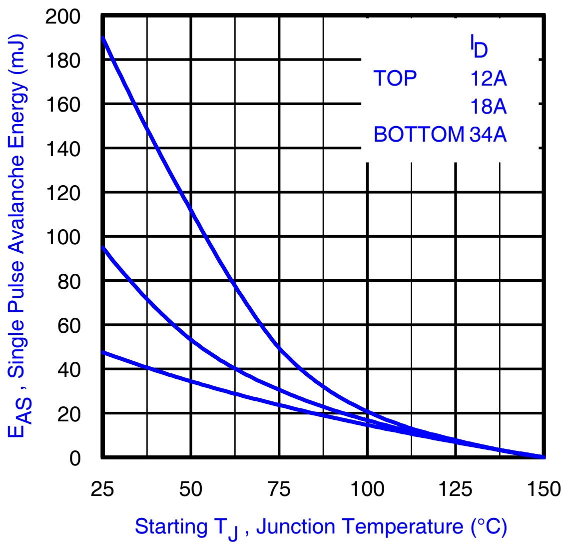


Fig 14. Maximum Avalanche Energy vs. Drain Current

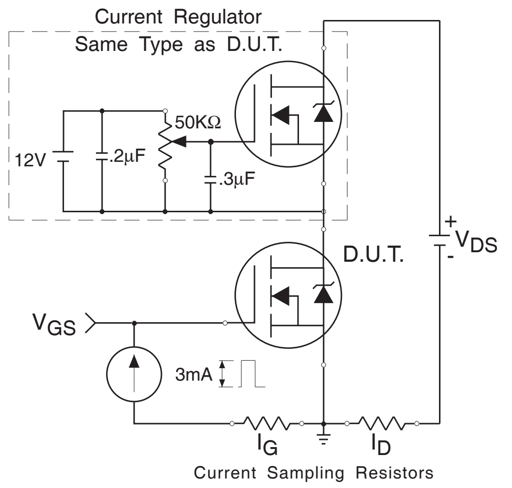


Fig 15a. Gate Charge Test Circuit

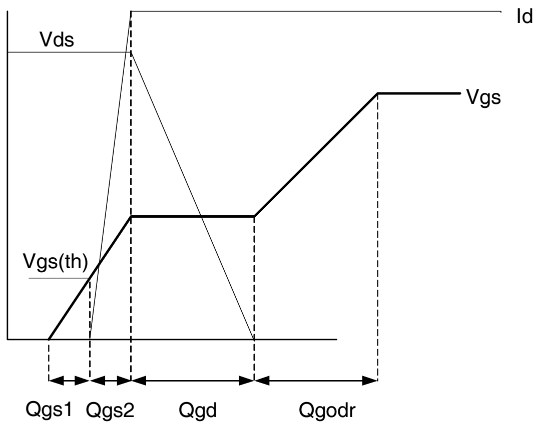


Fig 15b. Gate Charge Waveform

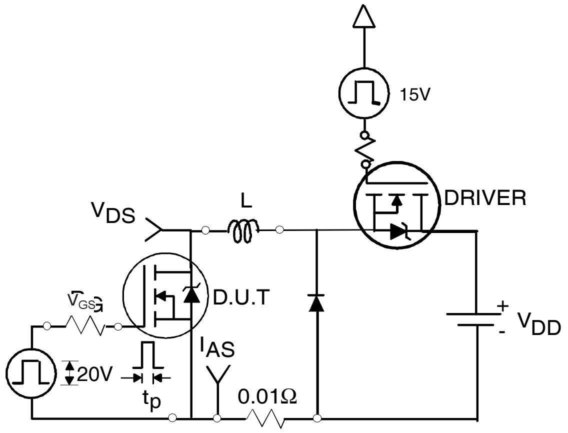


Fig 16a. Unclamped Inductive Test Circuit

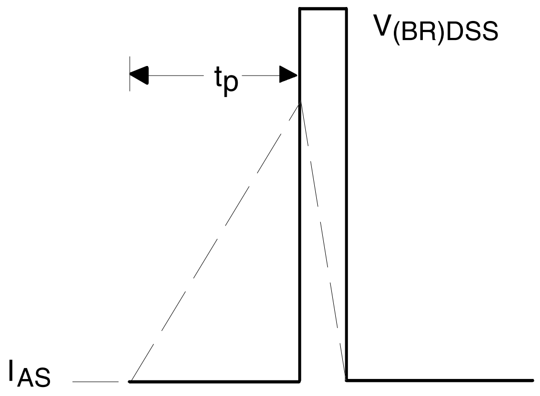


Fig 16b. Unclamped Inductive Waveforms

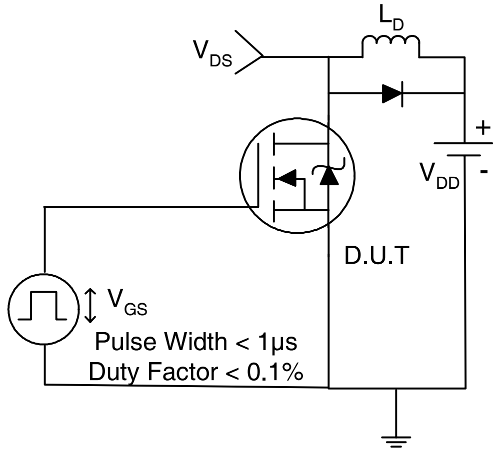


Fig 17a. Switching Time Test Circuit

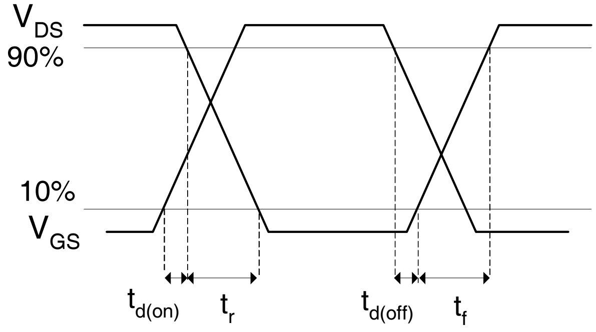


Fig 17b. Switching Time Waveforms

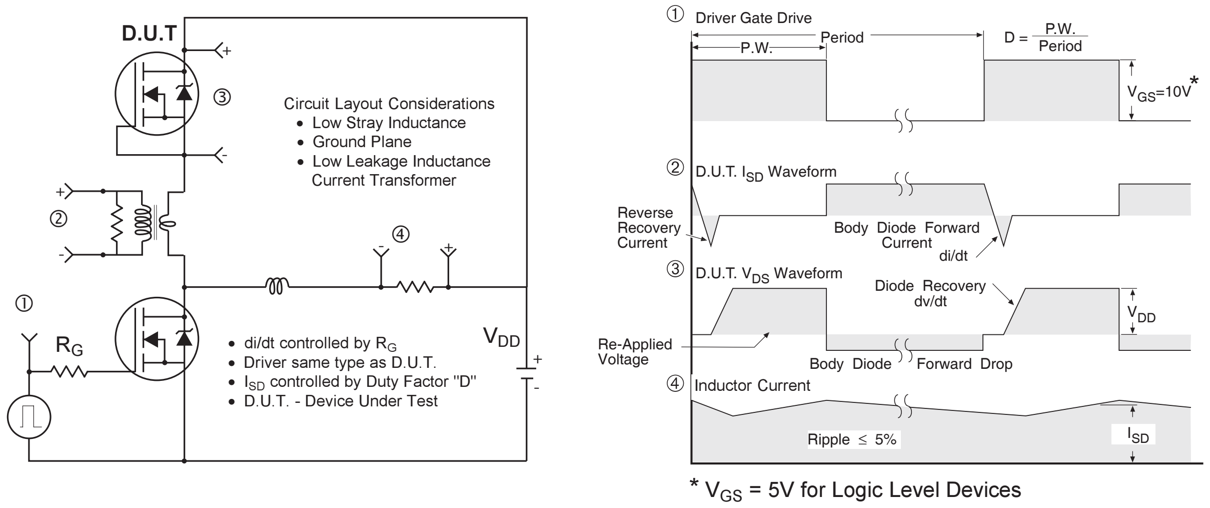
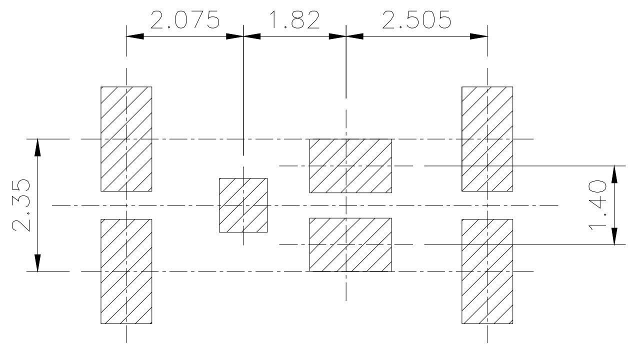
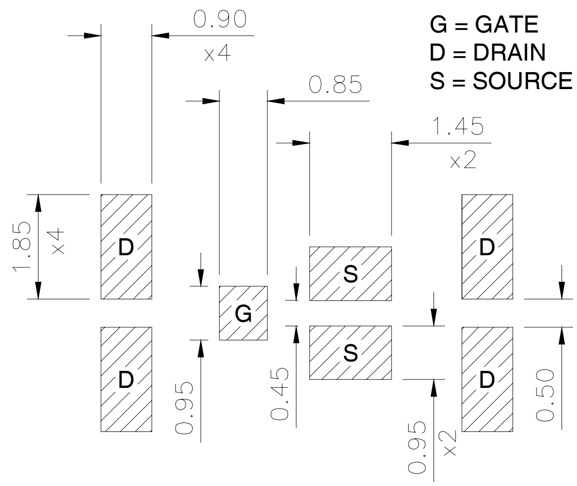


Fig 18. Diode Reverse Recovery Test Circuit for N-Channel HEXFET® Power MOSFETs

DirectFET™ Substrate and PCB Layout, MN Outline ③ (Medium Size Can, N-Designation).

Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET. This includes all recommendations for stencil and substrate designs.

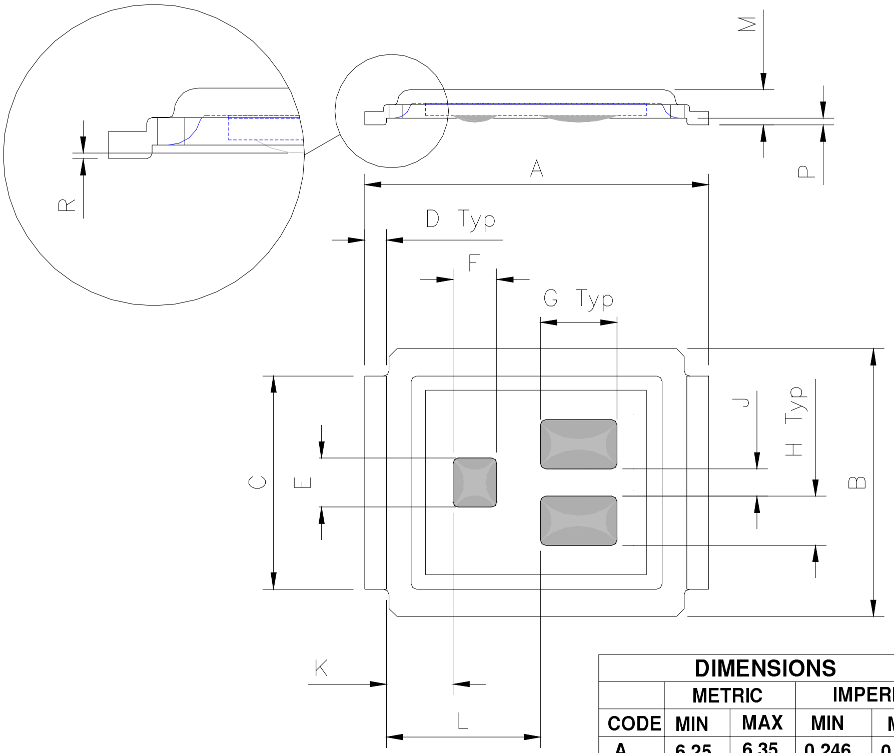




DirectFET™ Outline Dimension, MN Outline
(Medium Size Can, N-Designation).

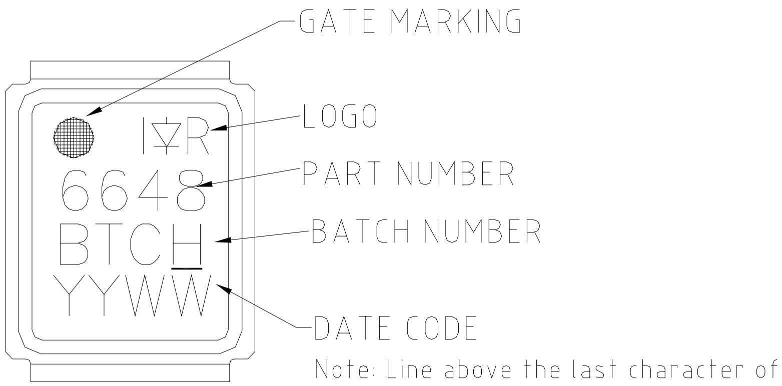
Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET.

This includes all recommendations for stencil and substrate designs.

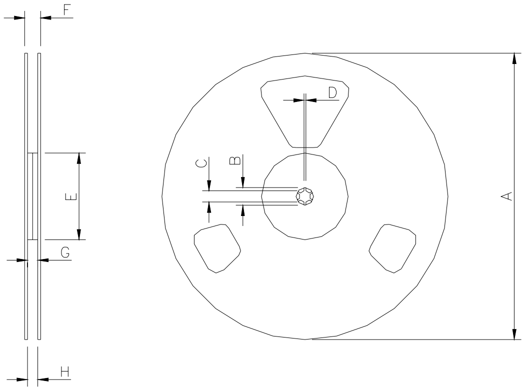


DIMENSIONS				
	METRIC		IMPERIAL	
CODE	MIN	MAX	MIN	MAX
A	6.25	6.35	0.246	0.250
B	4.80	5.05	0.189	0.201
C	3.85	3.95	0.152	0.156
D	0.35	0.45	0.014	0.018
E	0.88	0.92	0.034	0.036
F	0.78	0.82	0.031	0.032
G	1.38	1.42	0.054	0.056
H	0.88	0.92	0.034	0.036
J	0.48	0.52	0.019	0.020
K	1.16	1.29	0.046	0.051
L	2.74	2.91	0.109	0.115
M	0.616	0.676	0.0235	0.0274
R	0.020	0.080	0.0008	0.0031
P	0.08	0.17	0.003	0.007

DirectFET™ Part Marking



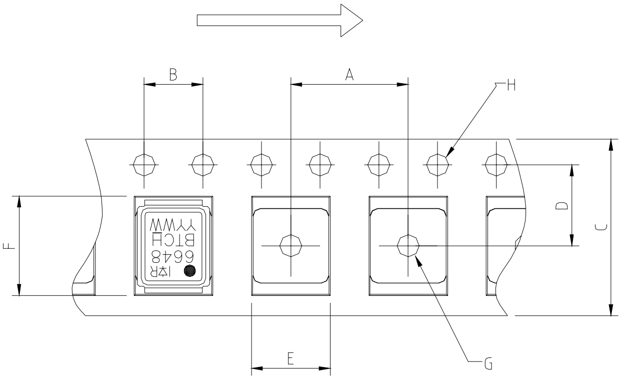
DirectFET™ Tape & Reel Dimension (Showing component orientation).



NOTE: Controlling dimensions in mm
Std reel quantity is 4800 parts. (ordered as IRF6648TRPBF). For 1000 parts on 7" reel, order IRF6648TR1PBF

REEL DIMENSIONS								
	STANDARD OPTION **(QTY 4800)**				TR1 OPTION **(QTY 1000)**			
	METRIC		IMPERIAL		METRIC		IMPERIAL	
CODE	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	330.0	N.C	12.992	N.C	177.77	N.C	6.9	N.C
B	20.2	N.C	0.795	N.C	19.06	N.C	0.75	N.C
C	12.8	13.2	0.504	0.520	13.5	12.8	0.53	0.50
D	1.5	N.C	0.059	N.C	1.5	N.C	0.059	N.C
E	100.0	N.C	3.937	N.C	58.72	N.C	2.31	N.C
F	N.C	18.4	N.C	0.724	N.C	13.50	N.C	0.53
G	12.4	14.4	0.488	0.567	11.9	12.01	0.47	N.C
H	11.9	15.4	0.469	0.606	11.9	12.01	0.47	N.C

LOADED TAPE FEED DIRECTION



DIMENSIONS				
	METRIC		IMPERIAL	
CODE	MIN	MAX	MIN	MAX
A	7.90	8.10	0.311	0.319
B	3.90	4.10	0.154	0.161
C	11.90	12.30	0.469	0.484
D	5.45	5.55	0.215	0.219
E	5.10	5.30	0.201	0.209
F	6.50	6.70	0.256	0.264
G	1.50	N.C	0.059	N.C
H	1.50	1.60	0.059	0.063

International
IOR Rectifier

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