International IƆR Rectifier

IRF6638PbF
IRF6638TRPbF

DirectFET™ Power MOSFET ②

- RoHs Compliant ①
- Lead-Free (Qualified up to 260°C Reflow)
- Application Specific MOSFETs
- Ideal for CPU Core DC-DC Converters
- Low Conduction Losses
- High Cdv/dt Immunity
- 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}	$R_{DS(on)}$	$R_{DS(on)}$
30V max	±20V max	2.2mΩ @ 10V	3.0mΩ @ 4.5V

$Q_{g\ tot}$	Q_{gd}	Q_{gs2}	Q_{rr}	Q_{oss}	$V_{gs(th)}$
30nC	11nC	3.2nC	27nC	18.4nC	1.8V

MX

DirectFET™ ISOMETRIC

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

SQ	SX	ST		MQ	**MX**	MT	MP			

Description

The IRF6638PbF 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 0.6 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, when 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 IRF6638PbF balances both low resistance and low charge along with ultra low package inductance to reduce both conduction and switching losses. The reduced total losses make this product ideal for high efficiency DC-DC converters that power the latest generation of processors operating at higher frequencies. The IRF6638PbF has been optimized for parameters that are critical in synchronous buck including Rds(on), gate charge and Cdv/dt-induced turn on immunity. The IRF6638PbF offers particularly low Rds(on) and high Cdv/dt immunity for synchronous FET applications.

Absolute Maximum Ratings

|	Parameter	Max.	Units
V_{DS}	Drain-to-Source Voltage	30	V
V_{GS}	Gate-to-Source Voltage	±20	
I_D @ T_A = 25°C	Continuous Drain Current, V_{GS} @ 10V ③	25	
I_D @ T_A = 70°C	Continuous Drain Current, V_{GS} @ 10V ③	20	A
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V ④	140	
I_{DM}	Pulsed Drain Current ⑤	200	
E_{AS}	Single Pulse Avalanche Energy ⑥	37	mJ
I_{AR}	Avalanche Current ⑤	20	A
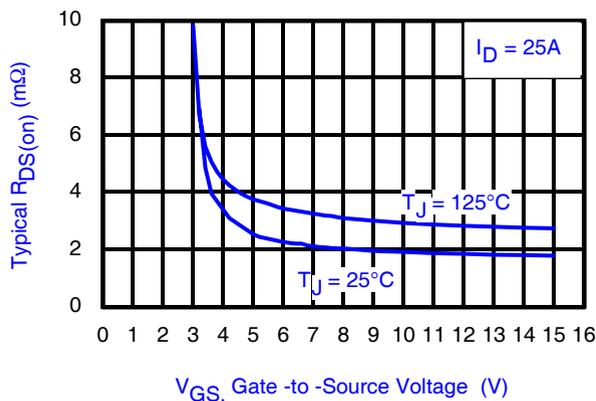
Fig 1. Typical On-Resistance Vs. Gate Voltage
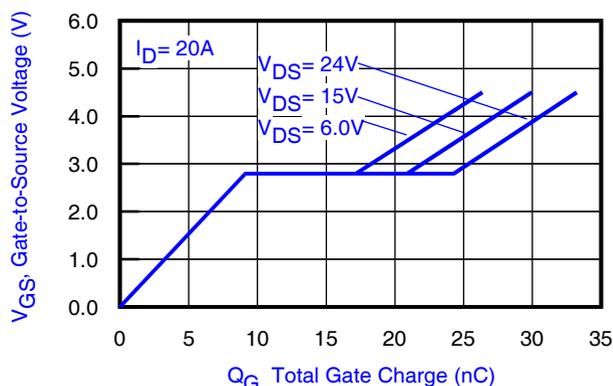
**Fig 2.** Typical Total Gate Charge vs Gate-to-Source Voltage

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 = 0.19mH, R_G = 25Ω, I_{AS} = 20A.

IRF6638PbF

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
ΔBV$_{DSS}$/ΔT$_J$	Breakdown Voltage Temp. Coefficient	——	22	——	mV/°C	Reference to 25°C, I$_D$ = 1mA
R$_{DS(on)}$	Static Drain-to-Source On-Resistance	——	2.2	2.9	mΩ	V$_{GS}$ = 10V, I$_D$ = 25A ⑦
		——	3.0	3.9		V$_{GS}$ = 4.5V, I$_D$ = 20A ⑦
V$_{GS(th)}$	Gate Threshold Voltage	1.35	1.8	2.35	V	V$_{DS}$ = V$_{GS}$, I$_D$ = 100µA
ΔV$_{GS(th)}$/ΔT$_J$	Gate Threshold Voltage Coefficient	——	-5.6	——	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	——	——	100	nA	V$_{GS}$ = 20V
	Gate-to-Source Reverse Leakage	——	——	-100		V$_{GS}$ = -20V
gfs	Forward Transconductance	105	——	——	S	V$_{DS}$ = 15V, I$_D$ = 20A
Q$_g$	Total Gate Charge	——	30	45		
Q$_{gs1}$	Pre-Vth Gate-to-Source Charge	——	6.7	——	nC	V$_{DS}$ = 15V
Q$_{gs2}$	Post-Vth Gate-to-Source Charge	——	3.2	——		V$_{GS}$ = 4.5V
Q$_{gd}$	Gate-to-Drain Charge	——	11	——		I$_D$ = 20A
Q$_{godr}$	Gate Charge Overdrive	——	9.1	——		See Fig. 15
Q$_{sw}$	Switch Charge (Q$_{gs2}$ + Q$_{gd}$)	——	14.2	——		
Q$_{oss}$	Output Charge	——	18.4	——	nC	V$_{DS}$ = 16V, V$_{GS}$ = 0V
R$_G$	Gate Resistance	——	1.3	——	Ω	
t$_{d(on)}$	Turn-On Delay Time	——	19	——		V$_{DD}$ = 16V, V$_{GS}$ = 4.5V ①
t$_r$	Rise Time	——	45	——		I$_D$ = 20A
t$_{d(off)}$	Turn-Off Delay Time	——	28	——	ns	Clamped Inductive Load
t$_f$	Fall Time	——	6.2	——		See Fig. 16 & 17
C$_{iss}$	Input Capacitance	——	3770	——		V$_{GS}$ = 0V
C$_{oss}$	Output Capacitance	——	810	——	pF	V$_{DS}$ = 15V
C$_{rss}$	Reverse Transfer Capacitance	——	410	——		ƒ = 1.0MHz

Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I$_S$	Continuous Source Current (Body Diode)	——	——	3.5	A	MOSFET symbol showing the integral reverse p-n junction diode.
I$_{SM}$	Pulsed Source Current (Body Diode) ⑤	——	——	200		
V$_{SD}$	Diode Forward Voltage	——	——	1.0	V	T$_J$ = 25°C, I$_S$ = 20A, V$_{GS}$ = 0V ⑦
t$_{rr}$	Reverse Recovery Time	——	19	29	ns	T$_J$ = 25°C, I$_F$ = 20A
Q$_{rr}$	Reverse Recovery Charge	——	27	41	nC	di/dt = 300A/µs ⑦ See Fig. 18
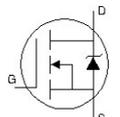
Notes:

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

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

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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	Operating Junction and	-40 to + 150	
T_{STG}	Storage Temperature Range		

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient ③ ❶	——	45	
$R_{\theta JA}$	Junction-to-Ambient ⑨ ❶	12.5	——	
$R_{\theta JA}$	Junction-to-Ambient ⑩ ❶	20	——	°C/W
$R_{\theta JC}$	Junction-to-Case ④ ❶	——	1.4	
$R_{\theta J\text{-}PCB}$	Junction-to-PCB Mounted	1.0	——	
	Linear Derating Factor ③	0.022		W/°C
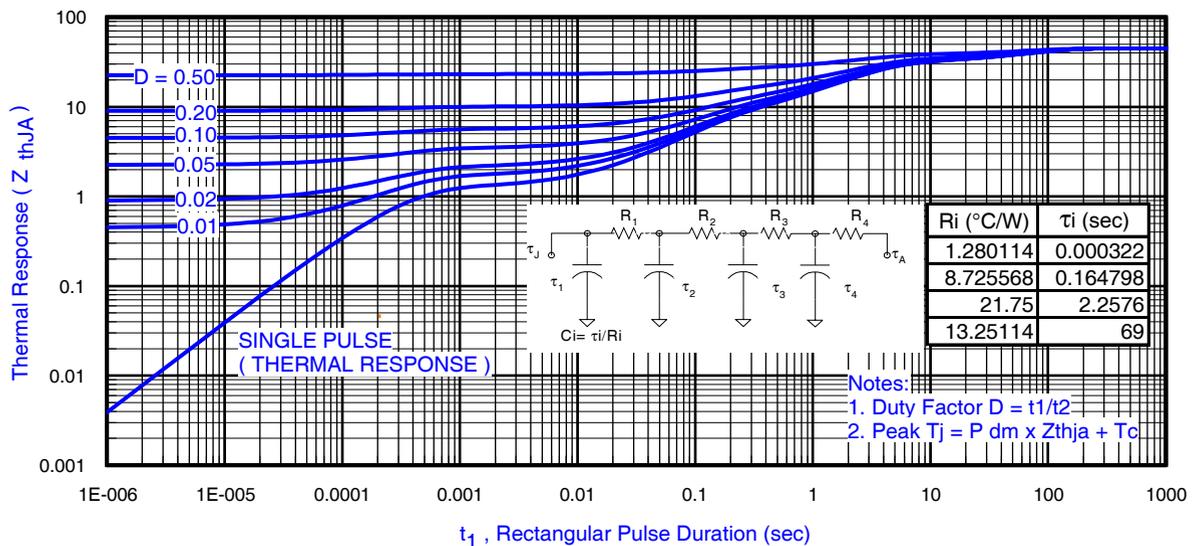
Fig 3. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient ①

Notes:
⑨ Used double sided cooling , mounting pad.
⑩ Mounted on minimum footprint full size board with metalized back and with small clip heatsink.

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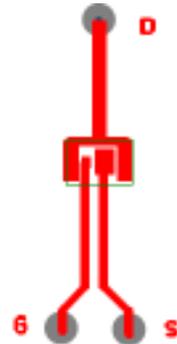
⑩ Mounted on minimum footprint full size board with metalized back and with small clip heatsink (still air)

IRF6638PbF

Fig 4. Typical Output Characteristics

Fig 5. Typical Output Characteristics

Fig 6. Typical Transfer Characteristics

Fig 7. Normalized On-Resistance vs. Temperature
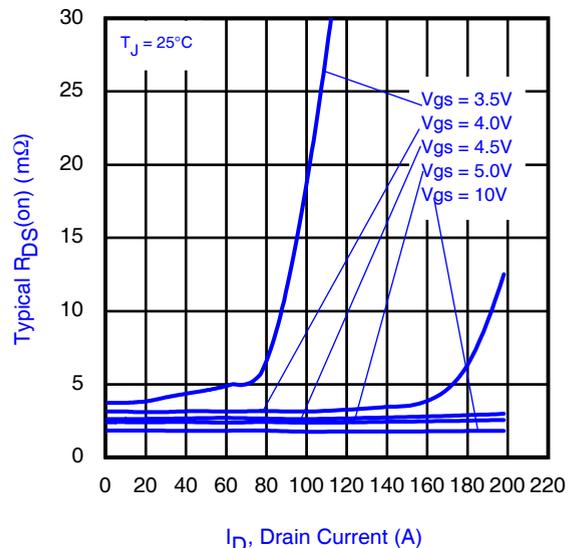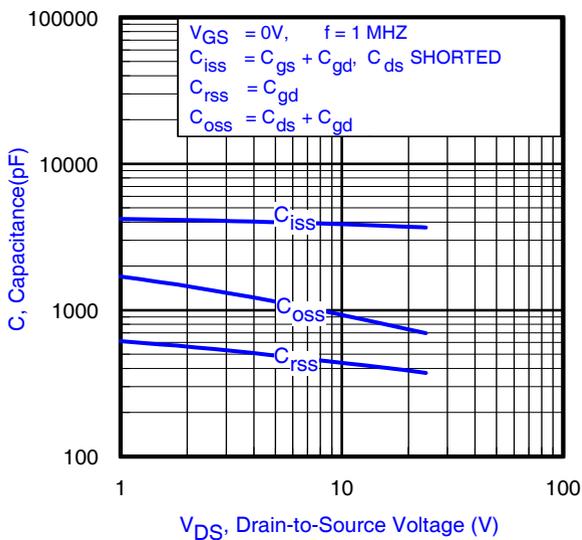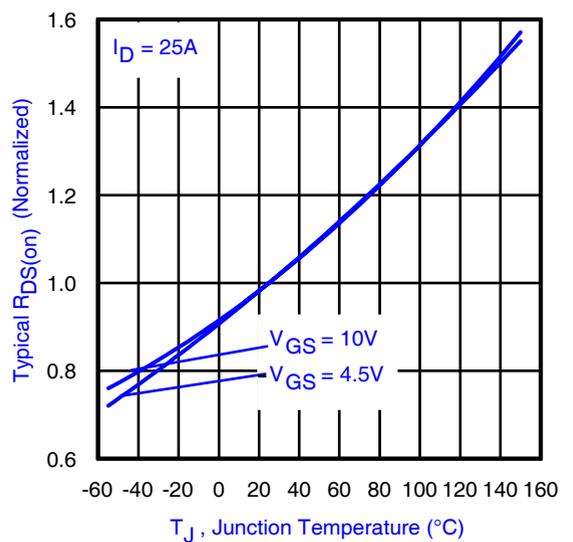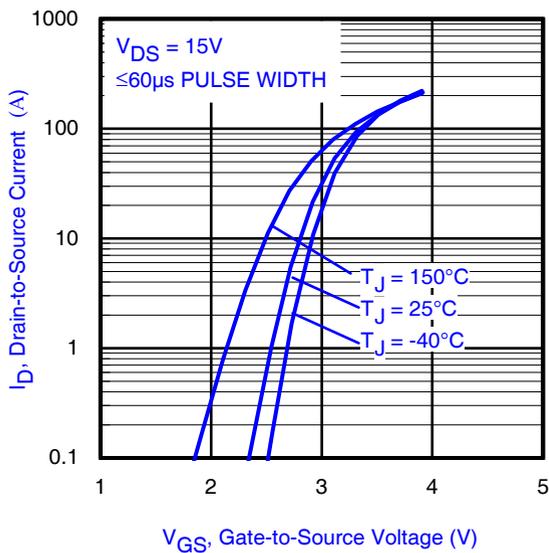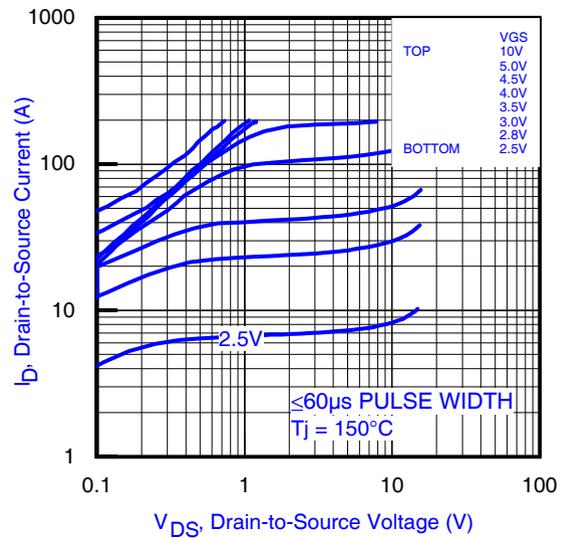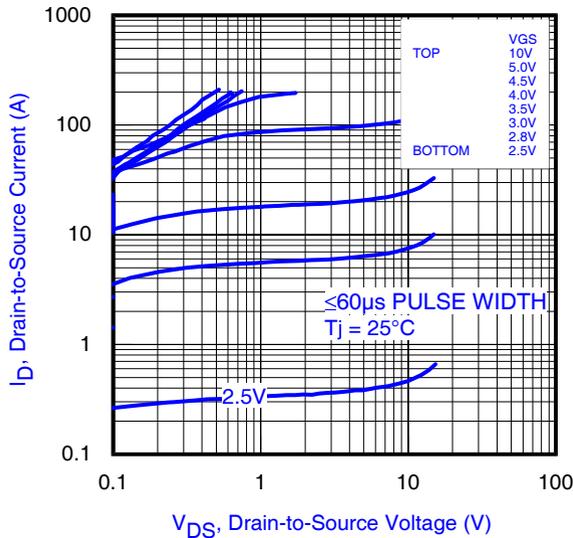
**Fig 8.** Typical Capacitance vs.Drain-to-Source Voltage

**Fig 9.** Typical On-Resistance Vs. Drain Current and Gate Voltage

IRF6638PbF
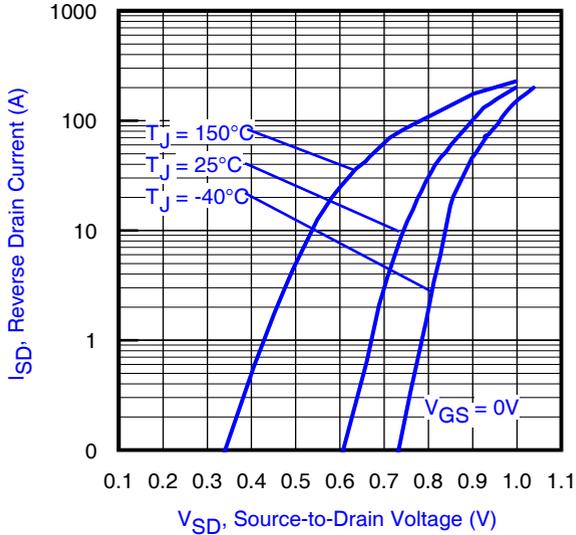
Fig 10. Typical Source-Drain Diode Forward Voltage
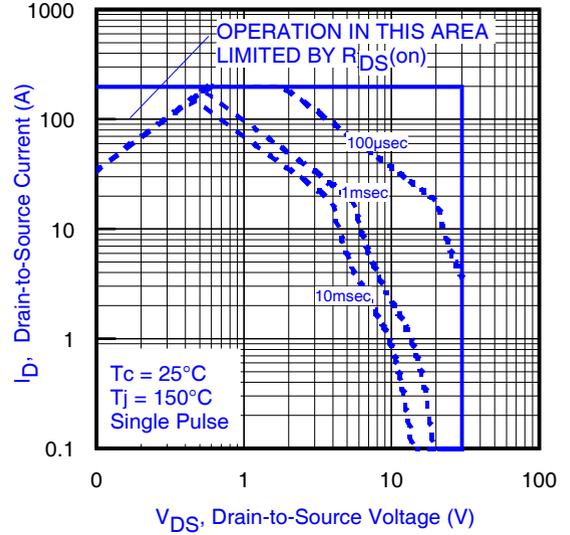

**Fig11.** Maximum Safe Operating Area
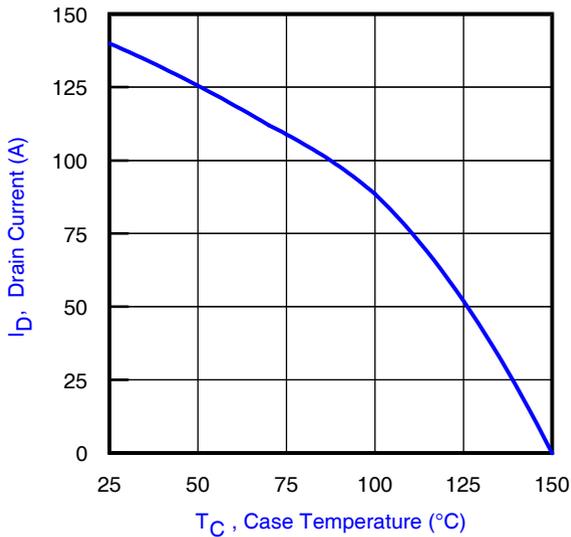

Fig 12. Maximum Drain Current vs. Case Temperature
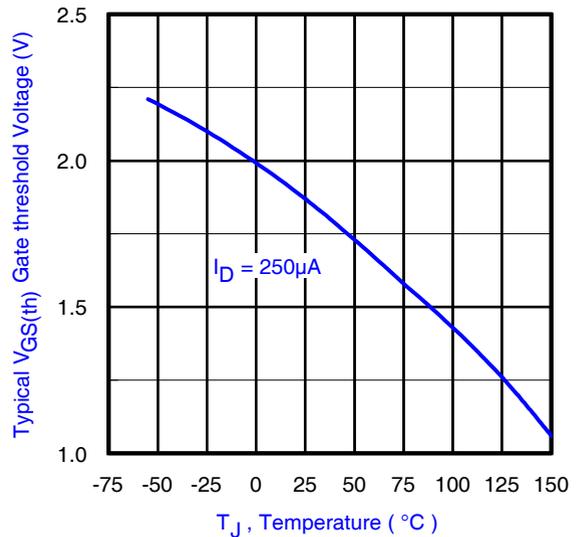
**Fig 13.** Typical Threshold Voltage vs. Junction Temperature
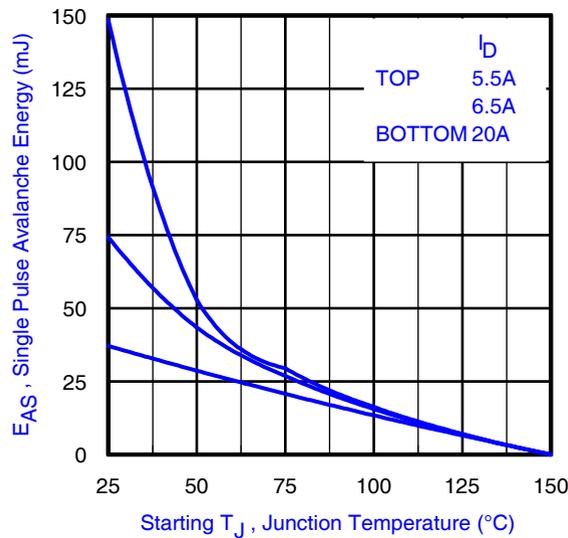
Fig 14. Maximum Avalanche Energy Vs. Drain Current

IRF6638PbF
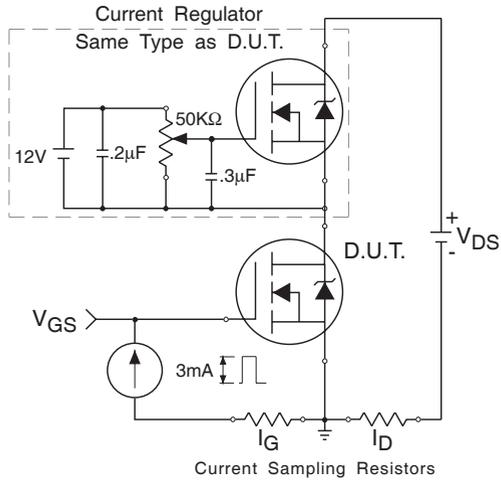
Fig 15a. Gate Charge Test Circuit
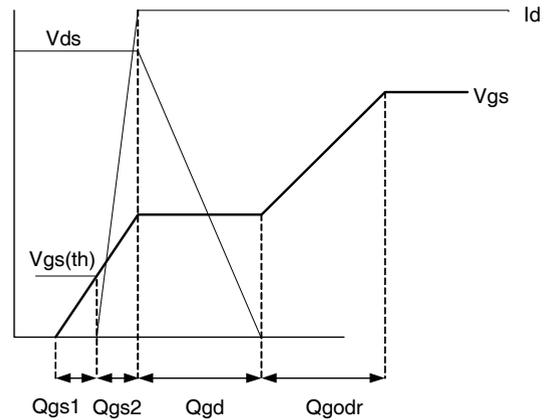
Fig 15b. Gate Charge Waveform
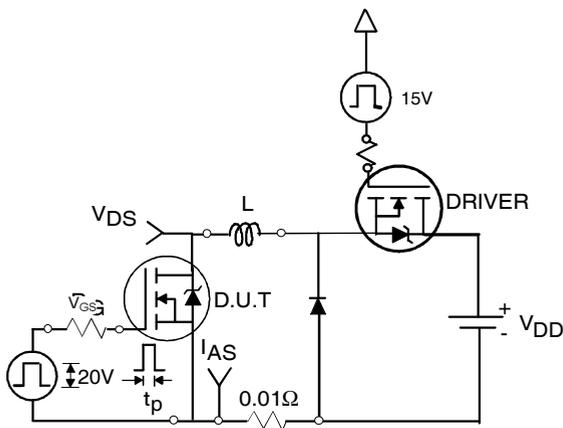
Fig 16a. Unclamped Inductive Test Circuit
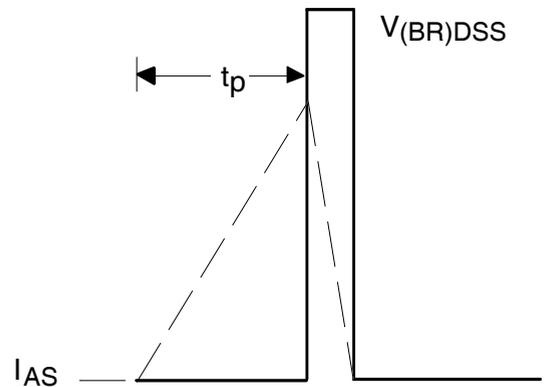
Fig 16b. Unclamped Inductive Waveforms
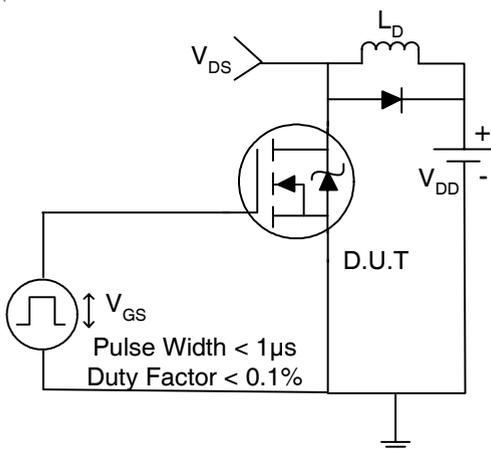


Fig 17a. Switching Time Test Circuit
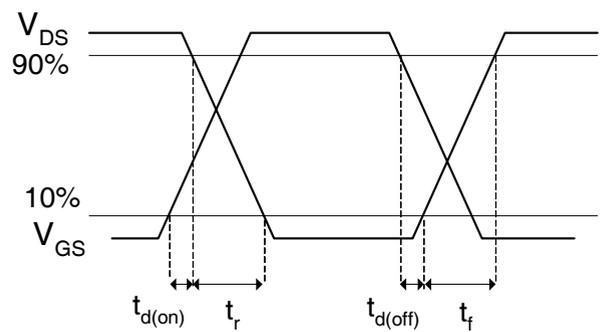
Fig 17b. Switching Time Waveforms
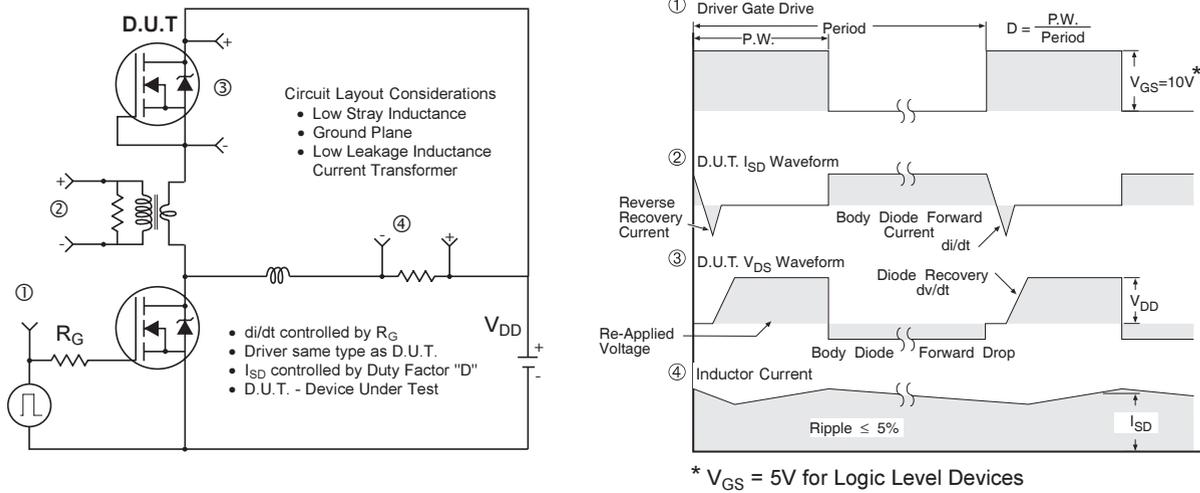
Fig 18. Diode Reverse Recovery Test Circuit for N-Channel
HEXFET® Power MOSFETs

DirectFET™ Board Footprint, MX Outline ③
(Medium Size Can, X-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.

G = GATE
D = DRAIN
S = SOURCE
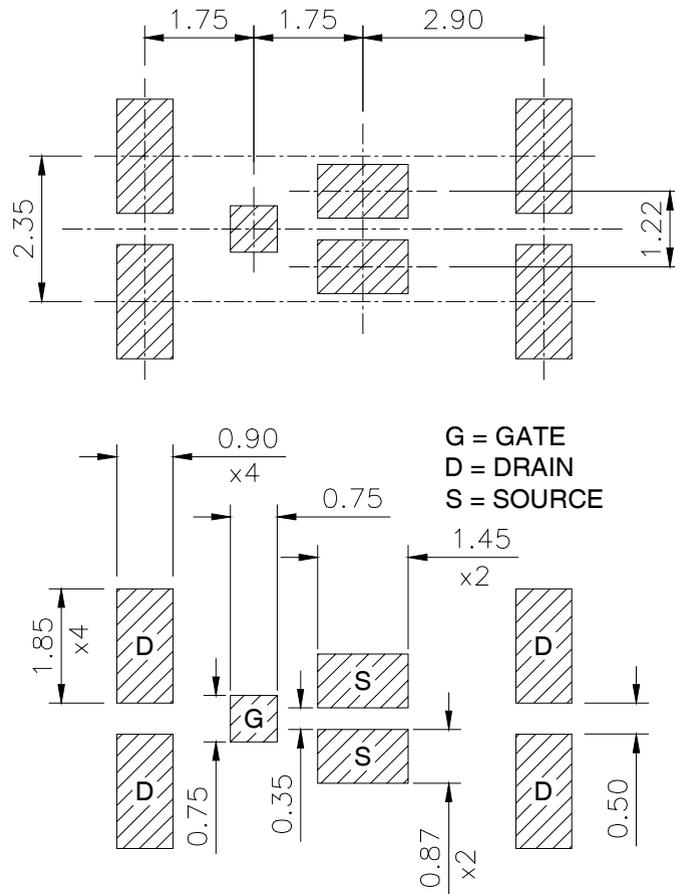
IRF6638PbF

DirectFET™ Outline Dimension, MX Outline
## (Medium Size Can, X-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.
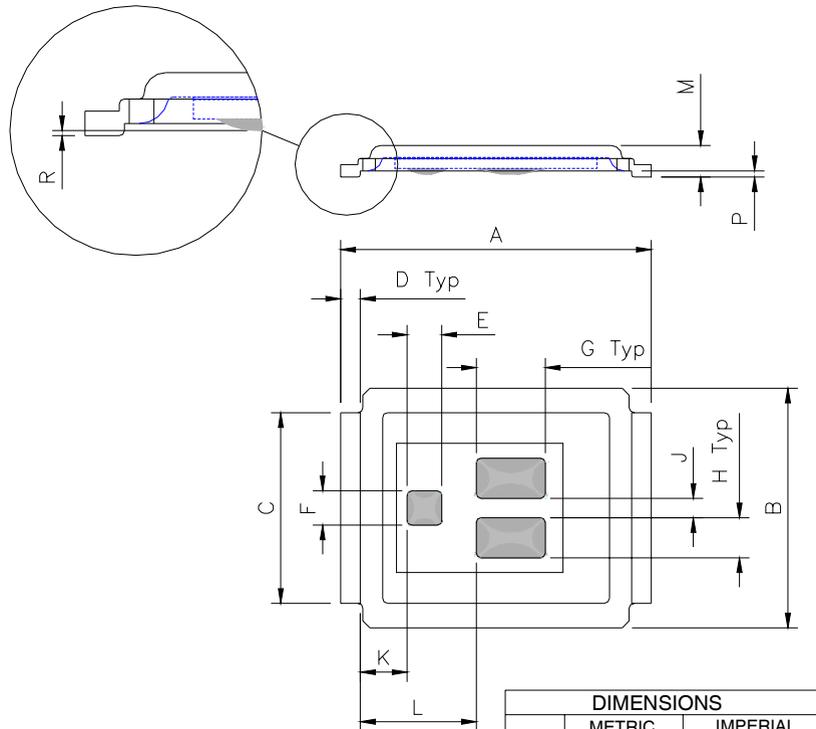
DIMENSIONS				
	METRIC		IMPERIAL	
CODE	MIN	MAX	MIN	MAX
A	6.25	6.35	0.246	0.250
B	4.80	5.05	0.189	0.201
C	3.85	3.95	0.152	0.156
D	0.35	0.45	0.014	0.018
E	0.68	0.72	0.027	0.028
F	0.68	0.72	0.027	0.028
G	1.38	1.42	0.054	0.056
H	0.80	0.84	0.032	0.033
J	0.38	0.42	0.015	0.017
K	0.88	1.01	0.035	0.039
L	2.28	2.41	0.090	0.095
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

GATE MARKING

LOGO

PART NUMBER

BATCH NUMBER
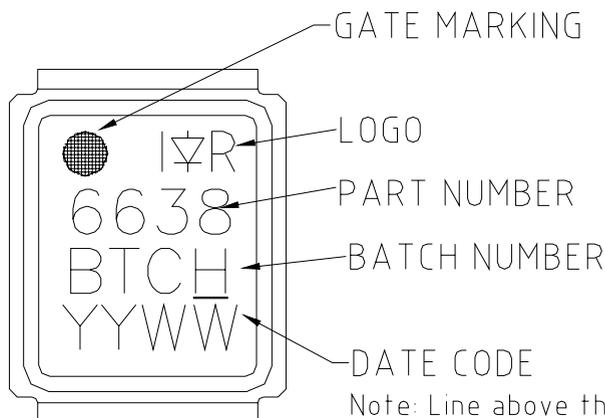
DATE CODE

Note: Line above the last character of the date-code indicates "Lead-Free".

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DirectFET™ Tape & Reel Dimension (Showing component orientation).
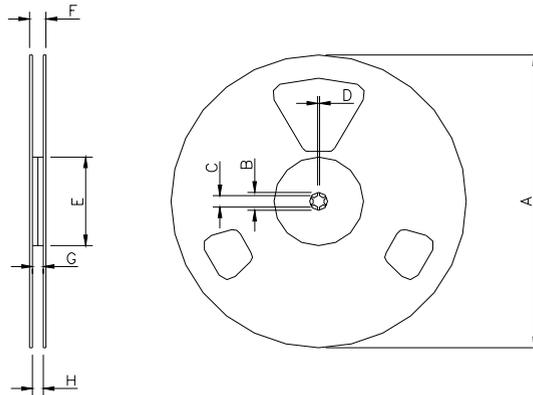
NOTE: Controlling dimensions in mm
Std reel quantity is 4800 parts. (ordered as IRF6638TRPBF). For 1000 parts on 7"
reel, order   IRF6638TR1PBF

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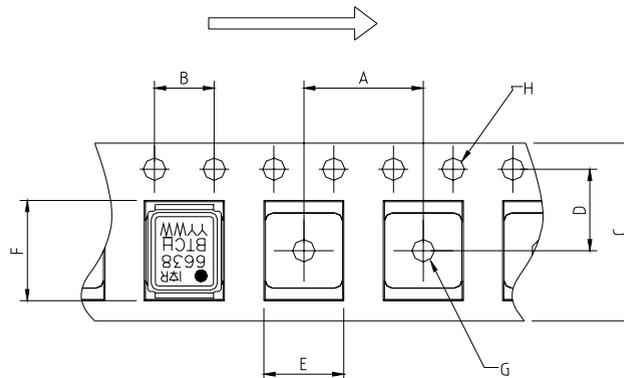
DIMENSIONS				
	METRIC		IMPERIAL	
CODE	MIN	MAX	MIN	MAX
A	7.90	8.10	0.311	0.319
B	3.90	4.10	0.154	0.161
C	11.90	12.30	0.469	0.484
D	5.45	5.55	0.215	0.219
E	5.10	5.30	0.201	0.209
F	6.50	6.70	0.256	0.264
G	1.50	N.C	0.059	N.C
H	1.50	1.60	0.059	0.063

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

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

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