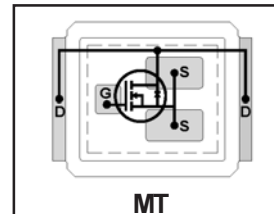


# IRF6613

HEXFET® Power MOSFET

- Application Specific MOSFETs
- Ideal for Synchronous Rectification in Isolated DC-DC Converters
- Low Conduction Losses
- Low Switching Losses
- Low Profile (<0.7 mm)
- Dual Sided Cooling Compatible
- Compatible with existing Surface Mount Techniques

$V_{DSS}$	$R_{DS(on)}$ max	$Qg$ (typ.)
40V	3.4m $\Omega$ @ $V_{GS} = 10V$	42nC
	4.1m $\Omega$ @ $V_{GS} = 4.5V$	



Applicable DirectFET Outline and Substrate Outline (see p.8,9 for details)

SQ	SX	ST		MQ	MX	<b>MT</b>			
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## Description

The IRF6613 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 an 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, 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 IRF6613 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 IRF6613 has been optimized for parameters that are critical in synchronous buck converters including  $R_{ds(on)}$ , gate charge and  $C_{dv/dt}$ -induced turn on immunity. The IRF6613 offers particularly low  $R_{ds(on)}$  and high  $C_{dv/dt}$  immunity for synchronous FET applications.

## Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{DS}$	Drain-to-Source Voltage	40	V
$V_{GS}$	Gate-to-Source Voltage	±20	
$I_D @ T_C = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ ⑦	150	A
$I_D @ T_A = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ ④	23	
$I_D @ T_A = 70^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ ④	18	
$I_{DM}$	Pulsed Drain Current ①	180	
$P_D @ T_C = 25^\circ C$	Power Dissipation ⑦	89	W
$P_D @ T_A = 25^\circ C$	Power Dissipation ④	2.8	
$P_D @ T_A = 70^\circ C$	Power Dissipation ④	1.8	
$E_{AS}$	Single Pulse Avalanche Energy②	200	
$I_{AR}$	Avalanche Current ①	18	A
	Linear Derating Factor ④	0.022	W/°C
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-40 to +150	°C

## Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient ④⑧	—	45	°C/W
$R_{\theta JA}$	Junction-to-Ambient ⑤⑧	12.5	—	
$R_{\theta JA}$	Junction-to-Ambient ⑥⑧	20	—	
$R_{\theta JC}$	Junction-to-Case ⑦⑧	—	1.4	
$R_{\theta J-PCB}$	Junction-to-PCB Mounted	1.0	—	

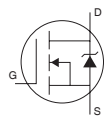
Notes ① through ⑧ are on page 2

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
$BV_{DSS}$	Drain-to-Source Breakdown Voltage	40	—	—	V	$V_{GS} = 0V, I_D = 250\mu A$
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	38	—	mV/ $^\circ\text{C}$	Reference to $25^\circ\text{C}, I_D = 1\text{mA}$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	2.6	3.4	m $\Omega$	$V_{GS} = 10V, I_D = 23A$ ③
		—	3.1	4.1		$V_{GS} = 4.5V, I_D = 18A$ ③
$V_{GS(th)}$	Gate Threshold Voltage	1.35	—	2.25	V	$V_{DS} = V_{GS}, I_D = 250\mu A$
$\Delta V_{GS(th)}/\Delta T_J$	Gate Threshold Voltage Coefficient	—	-5.8	—	mV/ $^\circ\text{C}$	
$I_{DSS}$	Drain-to-Source Leakage Current	—	—	1.0	$\mu A$	$V_{DS} = 32V, V_{GS} = 0V$
		—	—	150		$V_{DS} = 32V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	—	—	100	nA	$V_{GS} = 20V$
	Gate-to-Source Reverse Leakage	—	—	-100		$V_{GS} = -20V$
$g_{fs}$	Forward Transconductance	93	—	—	S	$V_{DS} = 15V, I_D = 18A$
$Q_g$	Total Gate Charge	—	42	63	nC	$V_{DS} = 20V$ $V_{GS} = 4.5V$ $I_D = 18A$ See Fig. 6 and 16
$Q_{gs1}$	Pre-Vth Gate-to-Source Charge	—	11.5	—		
$Q_{gs2}$	Post-Vth Gate-to-Source Charge	—	3.3	—		
$Q_{gd}$	Gate-to-Drain Charge	—	12.6	—		
$Q_{godr}$	Gate Charge Overdrive	—	14.6	—		
$Q_{sw}$	Switch Charge ( $Q_{gs2} + Q_{gd}$ )	—	15.9	—		
$Q_{oss}$	Output Charge	—	22	—	nC	$V_{DS} = 16V, V_{GS} = 0V$
$t_{d(on)}$	Turn-On Delay Time	—	18	—	ns	$V_{DD} = 16V, V_{GS} = 4.5V$ ③ $I_D = 18A$ Clamped Inductive Load
$t_r$	Rise Time	—	47	—		
$t_{d(off)}$	Turn-Off Delay Time	—	27	—		
$t_f$	Fall Time	—	4.9	—		
$C_{iss}$	Input Capacitance	—	5950	—	pF	$V_{GS} = 0V$ $V_{DS} = 15V$ $f = 1.0\text{MHz}$
$C_{oss}$	Output Capacitance	—	990	—		
$C_{rss}$	Reverse Transfer Capacitance	—	460	—		

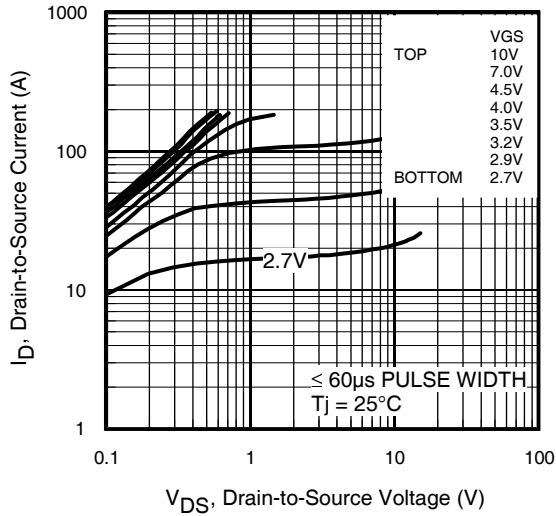
## Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_S$	Continuous Source Current (Body Diode)	—	—	110	A	MOSFET symbol showing the integral reverse p-n junction diode.
$I_{SM}$	Pulsed Source Current (Body Diode) ①	—	—	180		
$V_{SD}$	Diode Forward Voltage	—	—	1.0	V	$T_J = 25^\circ\text{C}, I_S = 18A, V_{GS} = 0V$ ③
$t_{rr}$	Reverse Recovery Time	—	38	57	ns	$T_J = 25^\circ\text{C}, I_F = 18A$
$Q_{rr}$	Reverse Recovery Charge	—	42	63	nC	$di/dt = 100A/\mu s$ ③

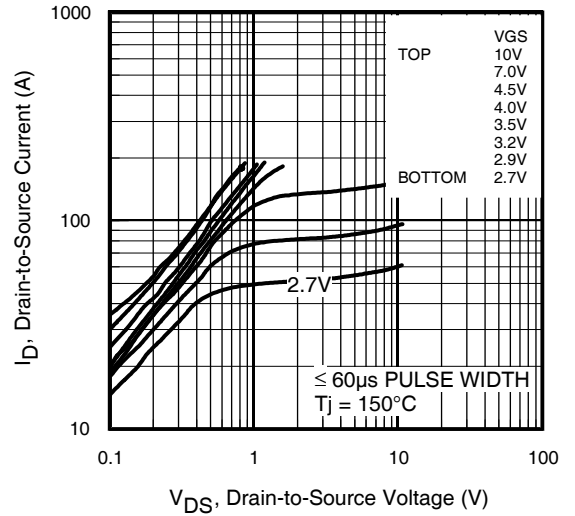


### Notes:

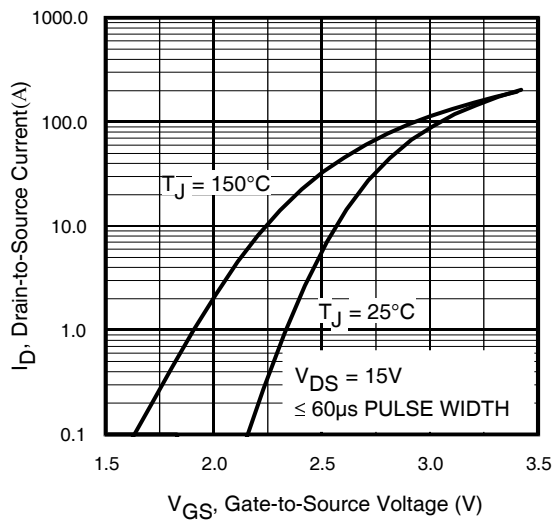
- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 1.2\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 18A$ .
- ③ Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .
- ④ Surface mounted on 1 in. square Cu board.
- ⑤ Used double sided cooling, mounting pad.
- ⑥ Mounted on minimum footprint full size board with metalized back and with small clip heatsink.
- ⑦  $T_C$  measured with thermal couple mounted to top (Drain) of part.
- ⑧  $R_\theta$  is measured at  $T_J$  of approximately  $90^\circ\text{C}$ .



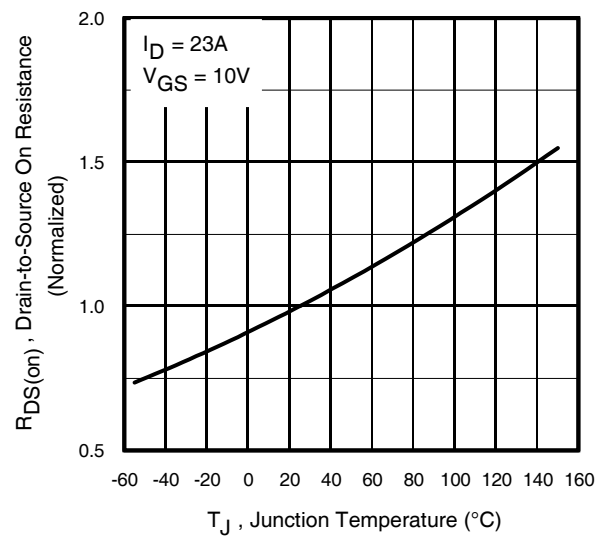
**Fig 1.** Typical Output Characteristics



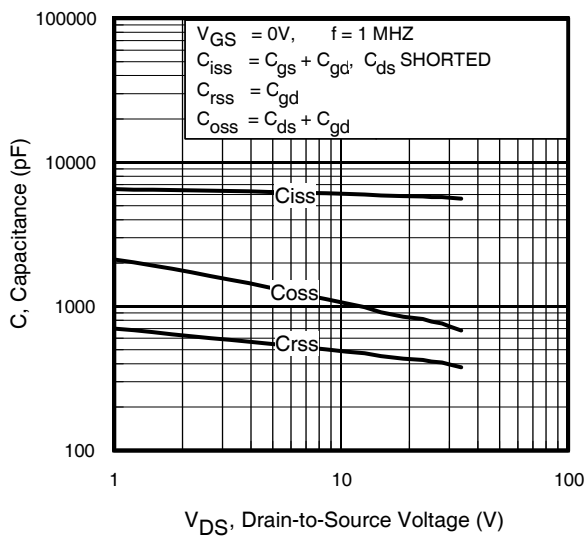
**Fig 2.** Typical Output Characteristics



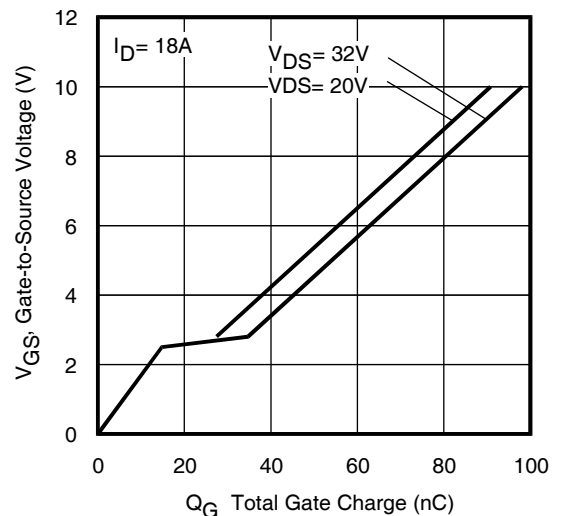
**Fig 3.** Typical Transfer Characteristics



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



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



**Fig 6.** Typical Gate Charge vs. Gate-to-Source Voltage  
 3

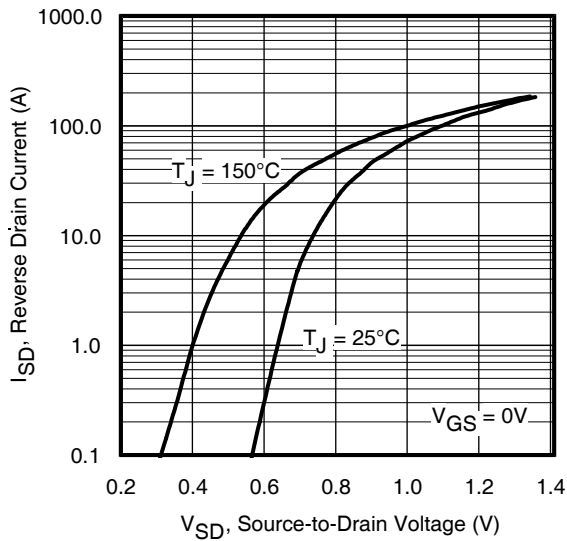


Fig 7. Typical Source-Drain Diode Forward Voltage

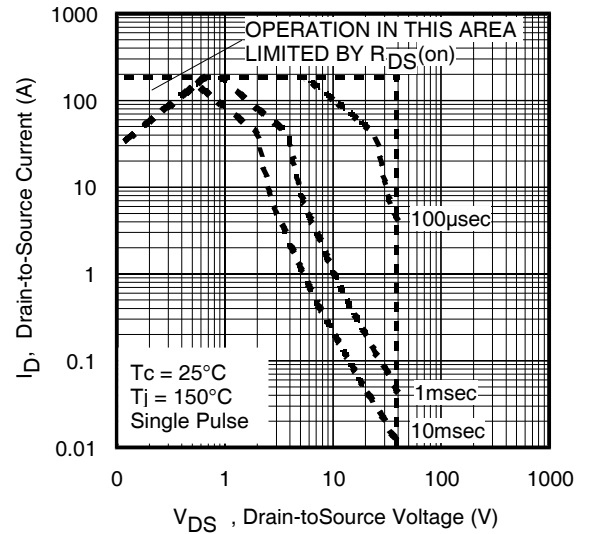


Fig 8. Maximum Safe Operating Area

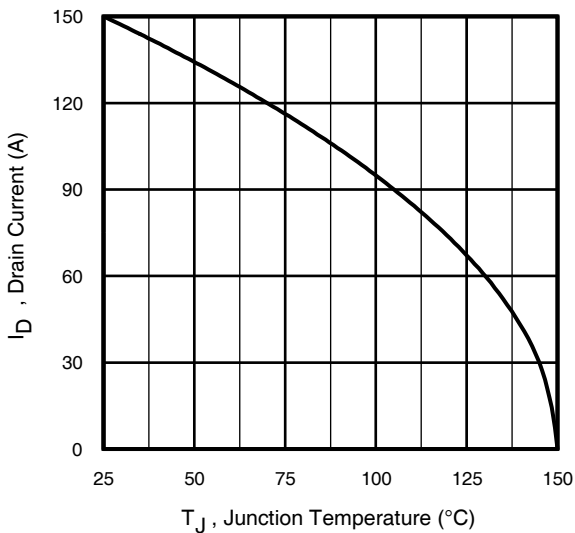


Fig 9. Maximum Drain Current vs. Case Temperature

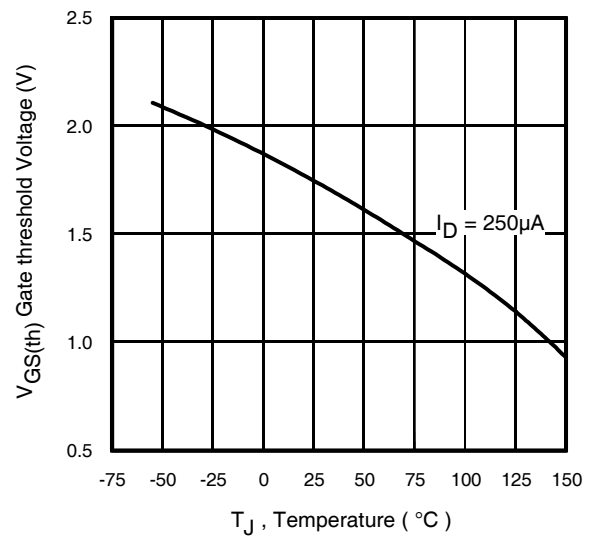


Fig 10. Threshold Voltage vs. Temperature

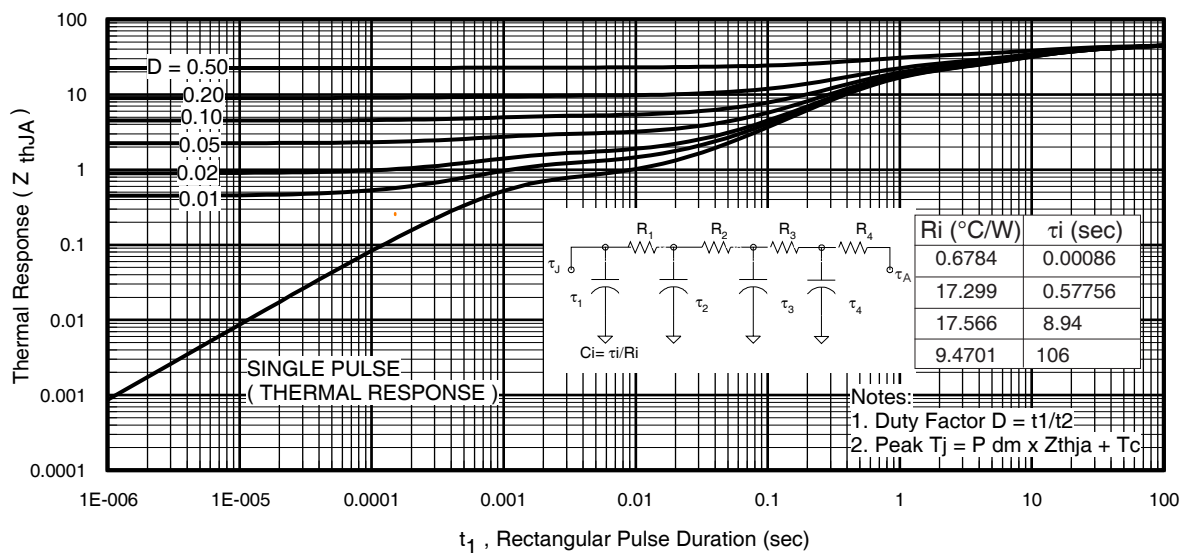
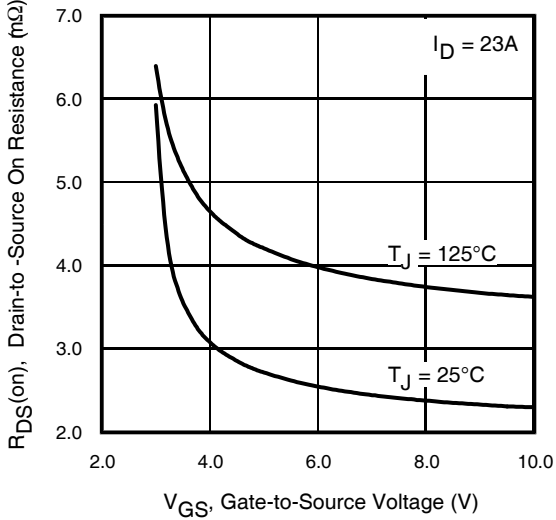
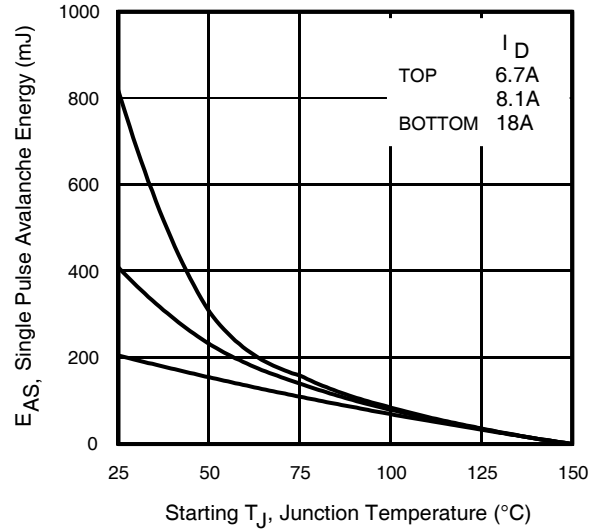


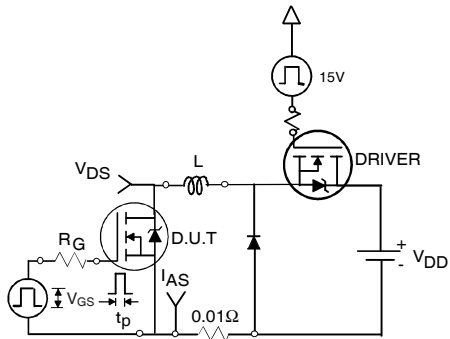
Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient



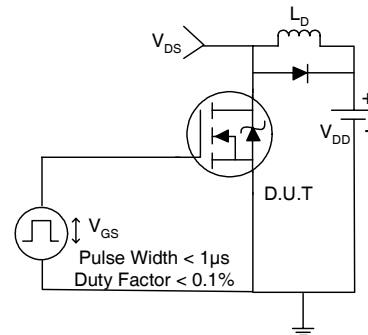
**Fig 12.** On-Resistance Vs. Gate Voltage



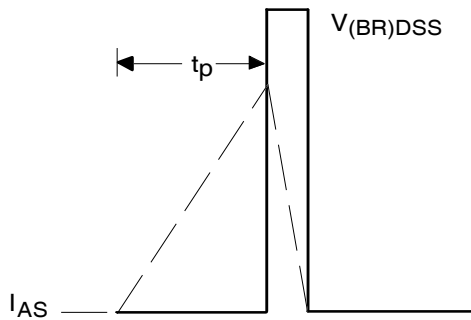
**Fig 13c.** Maximum Avalanche Energy Vs. Drain Current



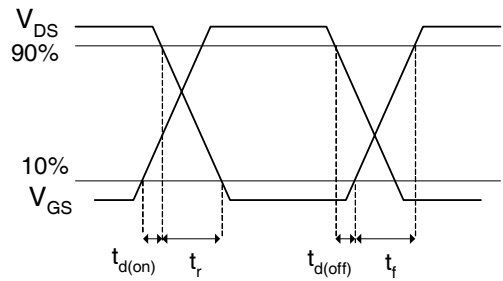
**Fig 13a.** Unclamped Inductive Test Circuit



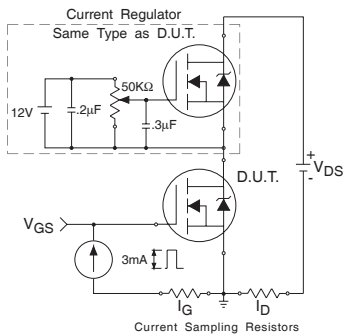
**Fig 14a.** Switching Time Test Circuit



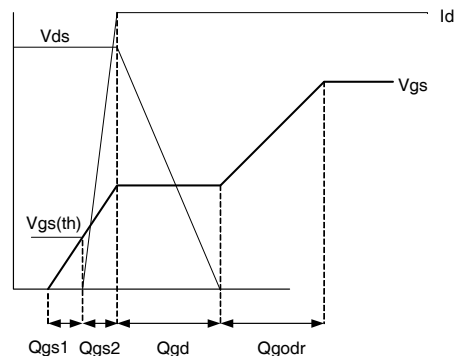
**Fig 13b.** Unclamped Inductive Waveforms



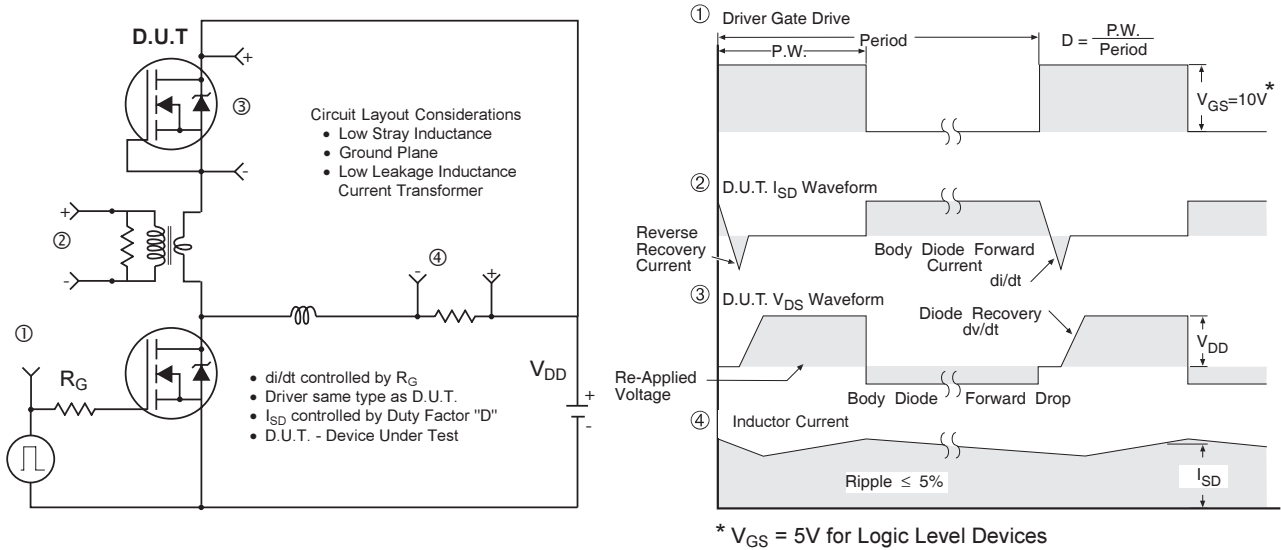
**Fig 14b.** Switching Time Waveforms



**Fig 15.** Gate Charge Test Circuit



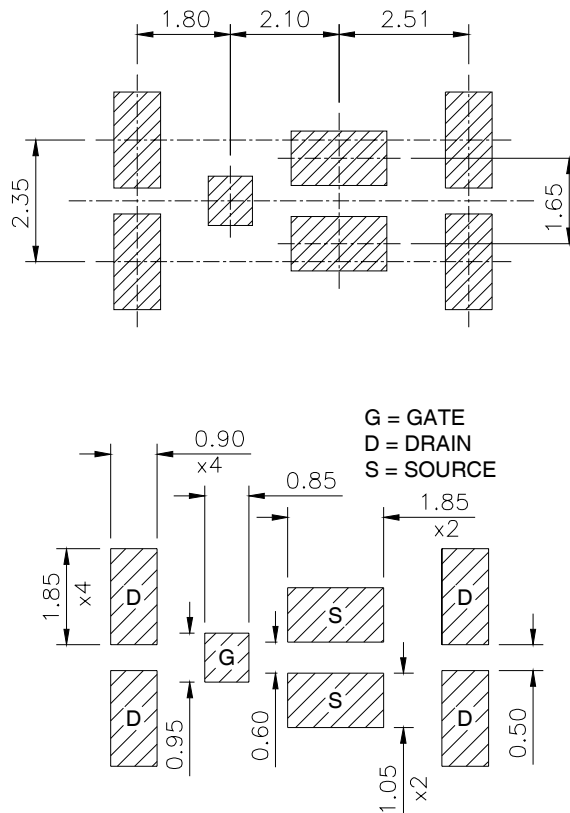
**Fig 16.** Gate Charge Waveform



**Fig 17. Diode Reverse Recovery Test Circuit for N-Channel HEXFET® Power MOSFETs**

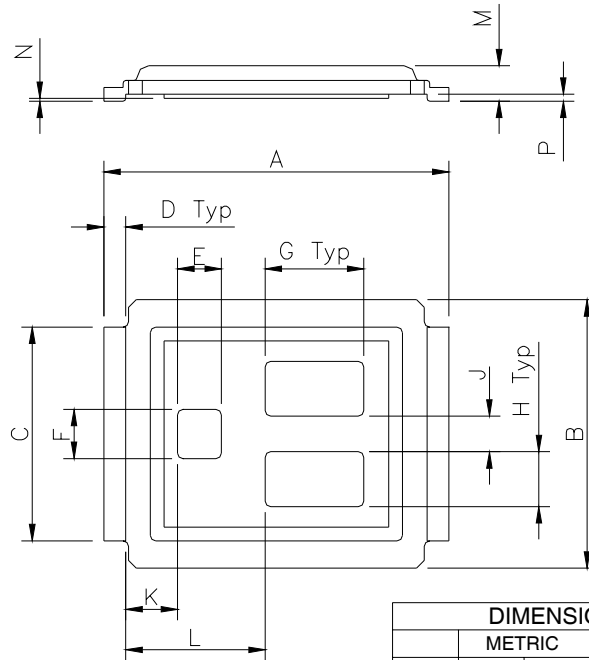
## DirectFET™ Substrate and PCB Layout, MT Outline (Medium Size Can, T-Designation).

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, MT Outline  
(Medium Size Can, T-Designation).**

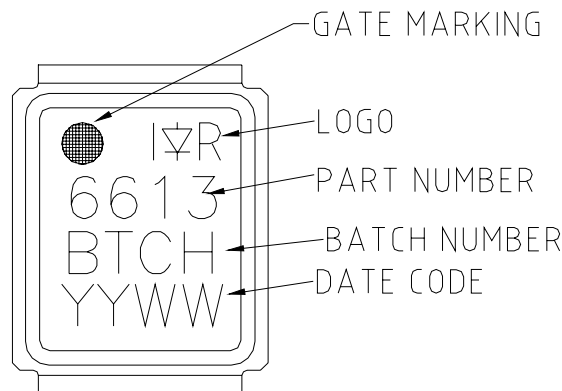
Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET. This includes all recommendations for stencil and substrate designs.



NOTE: CONTROLLING DIMENSIONS ARE IN MM

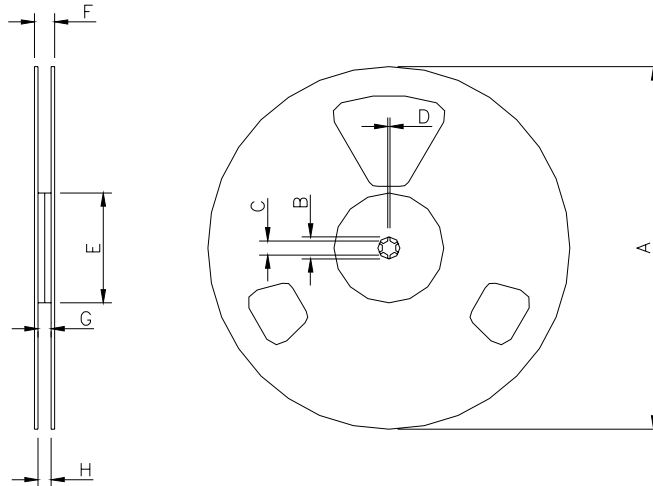
CODE	METRIC		IMPERIAL	
	MIN	MAX	MIN	MAX
A	6.25	6.35	0.246	0.250
B	4.80	5.05	0.189	0.199
C	3.85	3.95	0.152	0.156
D	0.35	0.45	0.014	0.018
E	0.78	0.82	0.031	0.032
F	0.88	0.92	0.035	0.036
G	1.78	1.82	0.070	0.072
H	0.98	1.02	0.039	0.040
J	0.63	0.67	0.025	0.026
K	0.88	1.01	0.035	0.039
L	2.46	2.63	0.097	0.104
M	0.59	0.70	0.023	0.028
N	0.03	0.08	0.001	0.003
P	0.08	0.17	0.003	0.007

**DirectFET™ Part Marking**



# IRF6613

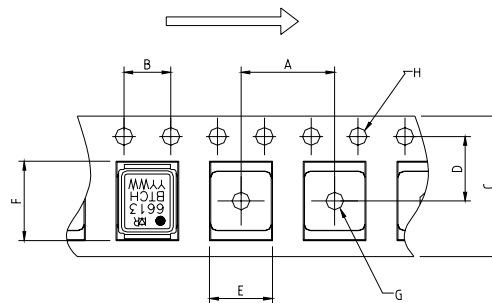
## DirectFET™ Tape & Reel Dimension (Showing component orientation).



NOTE: Controlling dimensions in mm  
Std reel quantity is 4800 parts. (ordered as IRF6613). For 1000 parts on 7" reel, order IRF6613TR1

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



NOTE: CONTROLLING DIMENSIONS IN MM

CODE	DIMENSIONS			
	METRIC		IMPERIAL	
	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.