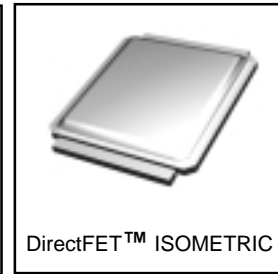
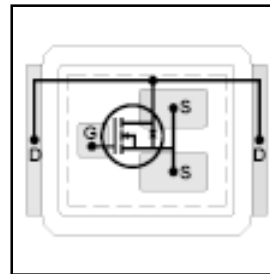


# IRF6601

DirectFET™ Power MOSFET

- Application Specific MOSFETs
- Ideal for CPU Core 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 <sub>DSS</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>
20V	3.8mΩ@V <sub>GS</sub> = 10V	26A
	5.0mΩ@V <sub>GS</sub> = 4.5V	21A



## Description

The IRF6601 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. The DirectFET package allows dual sided cooling to maximize thermal transfer in power systems, IMPROVING previous best thermal resistance by 80%.

The IRF6601 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 IRF6601 has been optimized for parameters that are critical in synchronous buck converters including R<sub>ds(on)</sub>, gate charge and C<sub>dv/dt</sub>-induced turn on immunity. The IRF6601 offers particularly low R<sub>ds(on)</sub> and high C<sub>dv/dt</sub> immunity for synchronous FET applications.

## Absolute Maximum Ratings

	Parameter	Max.	Units
V <sub>DS</sub>	Drain- Source Voltage	20	V
I <sub>D</sub> @ T <sub>C</sub> = 25°C	Continuous Drain Current, V <sub>GS</sub> @ 10V	85	A
I <sub>D</sub> @ T <sub>A</sub> = 25°C	Continuous Drain Current, V <sub>GS</sub> @ 10V	26	
I <sub>D</sub> @ T <sub>A</sub> = 70°C	Continuous Drain Current, V <sub>GS</sub> @ 10V	20	
I <sub>DM</sub>	Pulsed Drain Current ①	200	
P <sub>D</sub> @ T <sub>A</sub> = 25°C	Power Dissipation	3.6	W
P <sub>D</sub> @ T <sub>A</sub> = 70°C	Power Dissipation	2.3	
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Power Dissipation	42	
	Linear Derating Factor	28	mW/°C
V <sub>GS</sub>	Gate-to-Source Voltage	±20	V
T <sub>J</sub> , T <sub>STG</sub>	Junction and Storage Temperature Range	-55 to + 150	°C

## Thermal Resistance

Symbol	Parameter	Typ.	Max.	Units
R <sub>θJA</sub>	Junction-to-Ambient③	—	35	°C/W
R <sub>θJA</sub>	Junction-to-Ambient④	—	12.5	
R <sub>θJA</sub>	Junction-to-Ambient⑤	—	20	
R <sub>θJC</sub>	Junction-to-Case⑥	—	3.0	
R <sub>θJ-PCB</sub>	Junction-to-PCB mounted	—	1.0	

# IRF6601

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## Static @ T<sub>J</sub> = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)DSS</sub>	Drain-to-Source Breakdown Voltage	20	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 100μA
ΔV <sub>(BR)DSS/ΔT<sub>J</sub></sub>	Breakdown Voltage Temp. Coefficient	—	0.019	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-Resistance	—	—	3.8	mΩ	V <sub>GS</sub> = 10V, I <sub>D</sub> = 26A
		—	—	5.0		V <sub>GS</sub> = 4.5V, I <sub>D</sub> = 21A ②
V <sub>GS(th)</sub>	Gate Threshold Voltage	1.0	—	3.0	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA
I <sub>DSS</sub>	Drain-to-Source Leakage Current	—	—	20	μA	V <sub>DS</sub> = 16V, V <sub>GS</sub> = 0V
		—	—	100		V <sub>DS</sub> = 16V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 70°C
I <sub>GSS</sub>	Gate-to-Source Forward Leakage	—	—	100	nA	V <sub>GS</sub> = 20 V
	Gate-to-Source Reverse Leakage	—	—	-100		V <sub>GS</sub> = -20 V

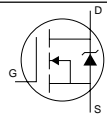
## Dynamic @ T<sub>J</sub> = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
g <sub>fs</sub>	Forward Transconductance	50	—	—	S	V <sub>DS</sub> = 10 V, I <sub>D</sub> = 21 A
Q <sub>g</sub>	Total Gate Charge Cont FET	—	36	54	nC	I <sub>D</sub> = 21A
Q <sub>gs</sub>	Gate-to-Source Charge	—	11	—		V <sub>DS</sub> = 16 V
Q <sub>gd</sub>	Gate to Drain ("Miller") Charge	—	12	—		V <sub>GS</sub> = 4.5 V,
Q <sub>oss</sub>	Output Charge	—	48	—		V <sub>DS</sub> = 0 V, V <sub>GS</sub> = 16V
t <sub>d(on)</sub>	Turn-On Delay Time	—	16	—	ns	V <sub>DD</sub> = 15 V
t <sub>r</sub>	Rise Time	—	140	—		I <sub>D</sub> = 21 A
t <sub>d(off)</sub>	Turn-Off Delay Time	—	33	—		R <sub>G</sub> = 5.1 Ω
t <sub>f</sub>	Fall Time	—	110	—		V <sub>GS</sub> = 4.5 V ②
C <sub>iss</sub>	Input Capacitance	—	3440	—	pF	V <sub>GS</sub> = 0V
C <sub>oss</sub>	Output Capacitance	—	2430	—		V <sub>DS</sub> = 10V
C <sub>rss</sub>	Reverse Transfer Capacitance	—	380	—		f = 1.0MHz

## Avalanche Characteristics

Symbol	Parameter	Typ.	Max.	Units
E <sub>AS</sub>	Single Pulse Avalanche Energy②	—	65	mJ
I <sub>AR</sub>	Avalanche Current①	—	21	A

## Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	26	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I <sub>SM</sub>	Pulsed Source Current (Body Diode) ①	—	—	200		
V <sub>SD</sub>	Diode Forward Voltage	—	0.83	1.2	V	T <sub>J</sub> = 25°C, I <sub>S</sub> = 21A, V <sub>GS</sub> = 0V ②
		—	0.68	—		T <sub>J</sub> = 125°C, I <sub>S</sub> = 21A, V <sub>GS</sub> = 0V ②
t <sub>rr</sub>	Reverse Recovery Time	—	60	90	ns	T <sub>J</sub> = 25°C, I <sub>F</sub> = 21A, V <sub>R</sub> = 15 V
Q <sub>rr</sub>	Reverse Recovery Charge	—	94	140	nC	di/dt = 100A/μs ②
t <sub>rr</sub>	Reverse Recovery Time	—	62	93	ns	T <sub>J</sub> = 125°C, I <sub>F</sub> = 21A, V <sub>R</sub> = 15 V
Q <sub>rr</sub>	Reverse Recovery Charge	—	88	130	nC	di/dt = 100A/μs ②

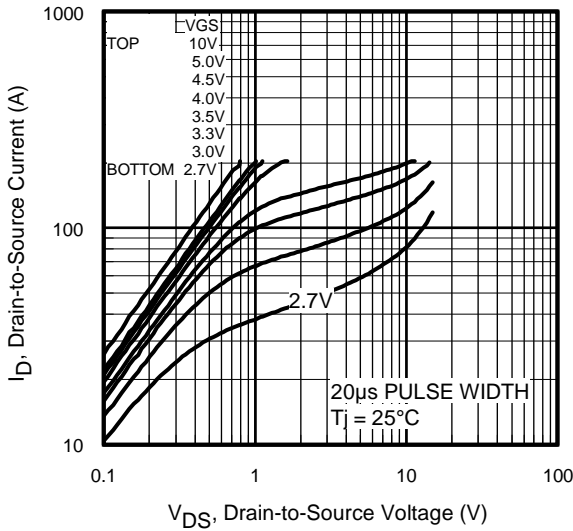


Fig 1. Typical Output Characteristics

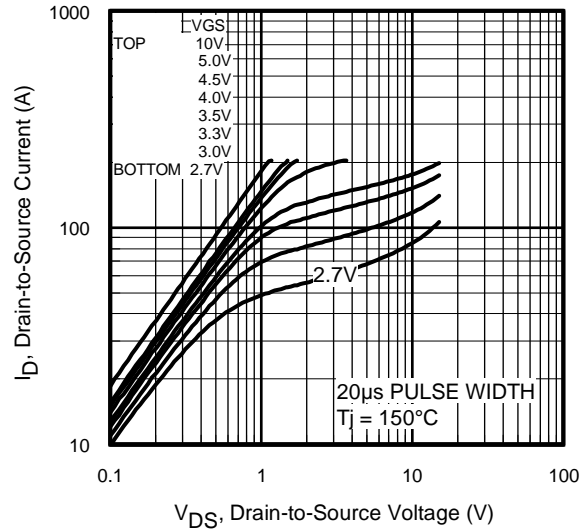


Fig 2. Typical Output Characteristics

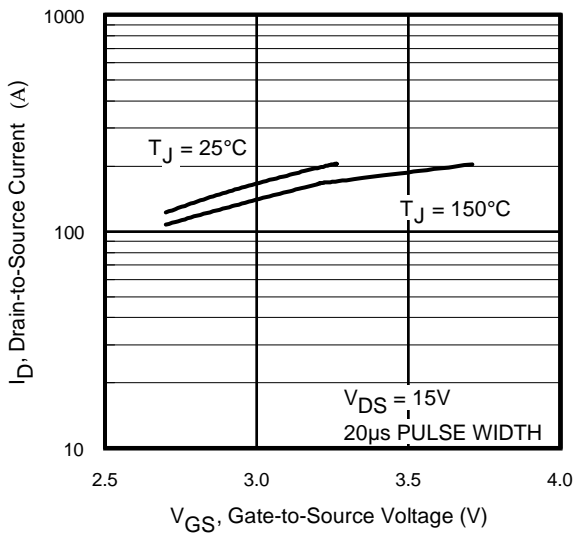


Fig 3. Typical Transfer Characteristics

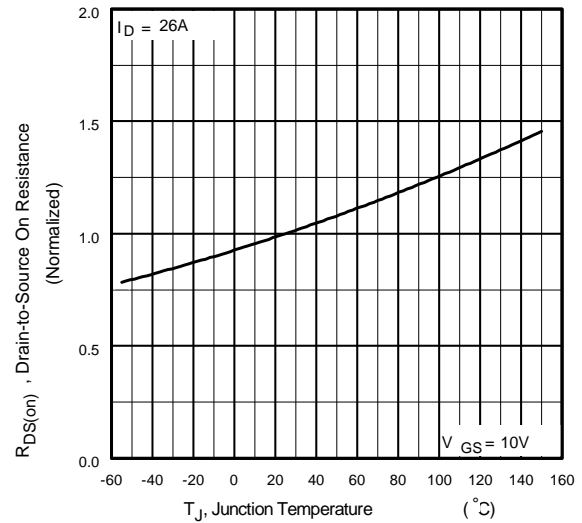
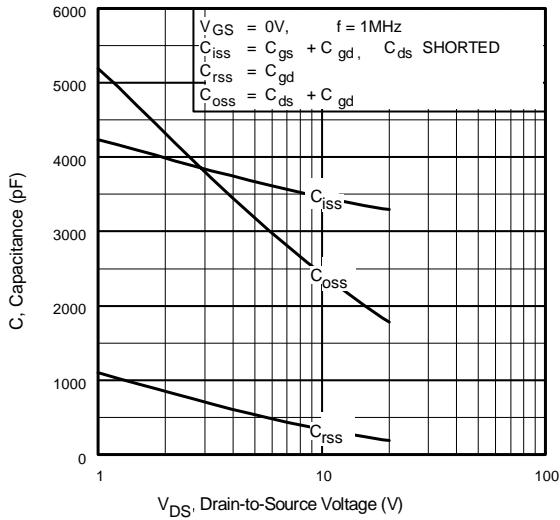
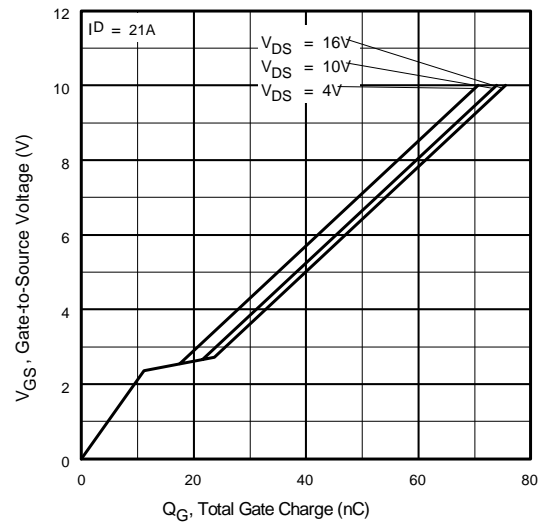


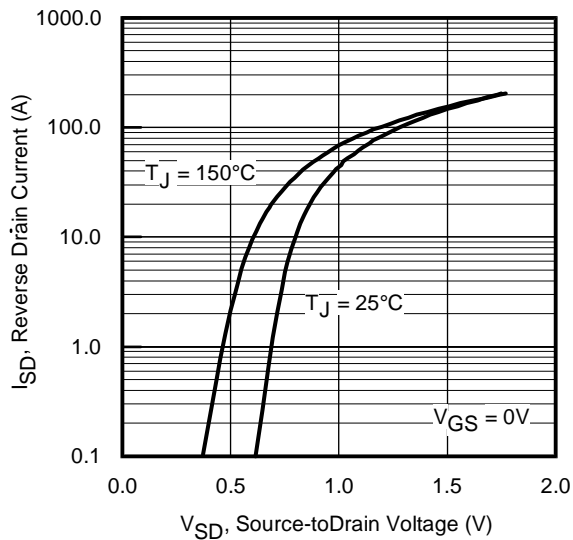
Fig 4. Normalized On-Resistance Vs. Temperature



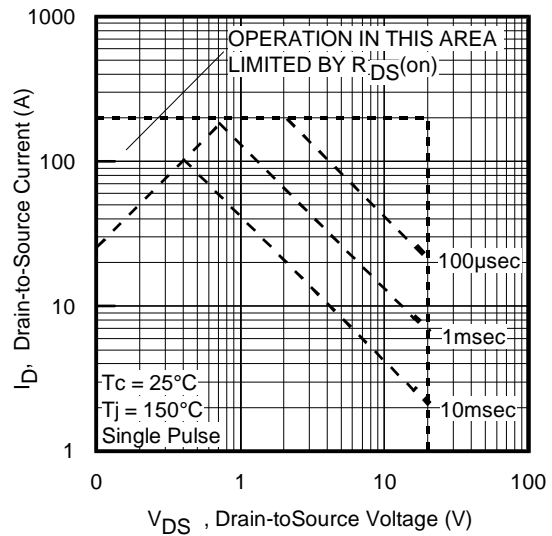
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



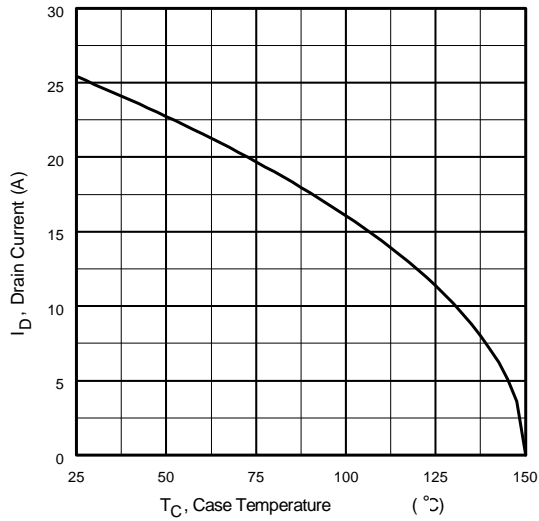
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



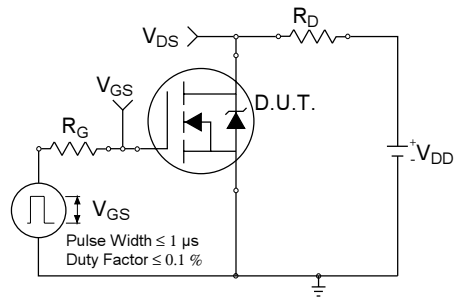
**Fig 7.** Typical Source-Drain Diode Forward Voltage



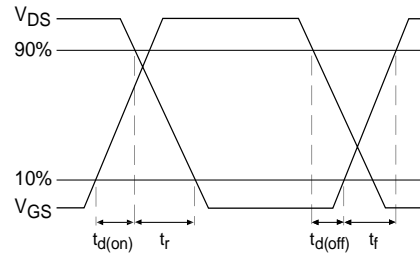
**Fig 8.** Maximum Safe Operating Area



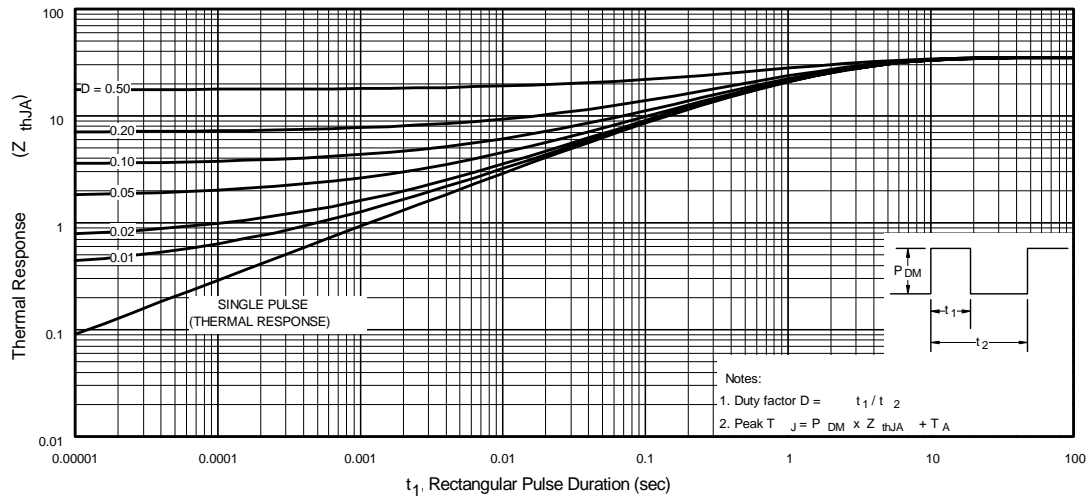
**Fig 9.** Maximum Drain Current Vs. Ambient Temperature



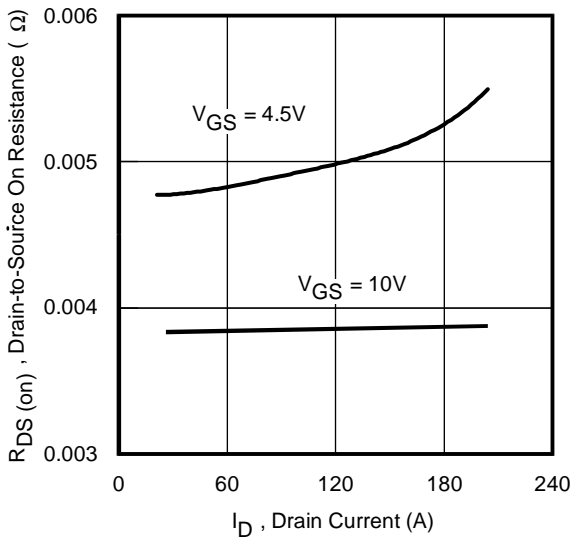
**Fig 10a.** Switching Time Test Circuit



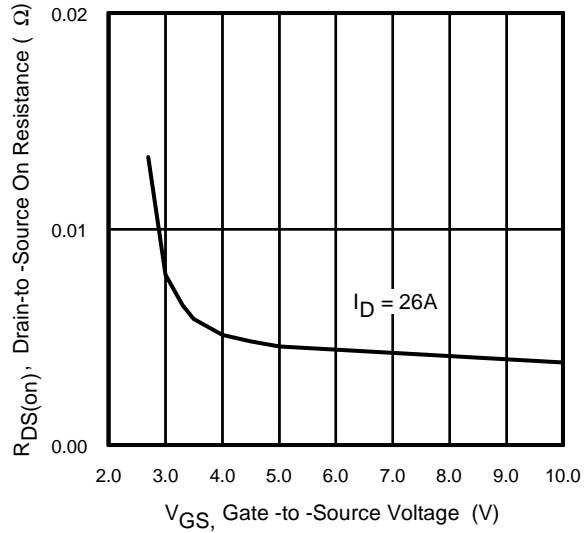
**Fig 10b.** Switching Time Waveforms



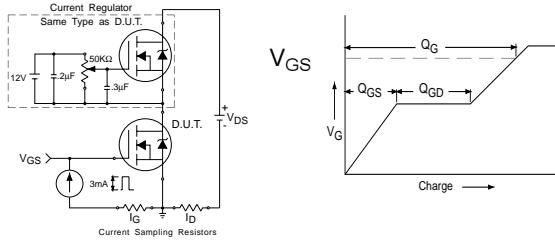
**Fig 10.** Maximum Effective Transient Thermal Impedance, Junction-to-Ambient



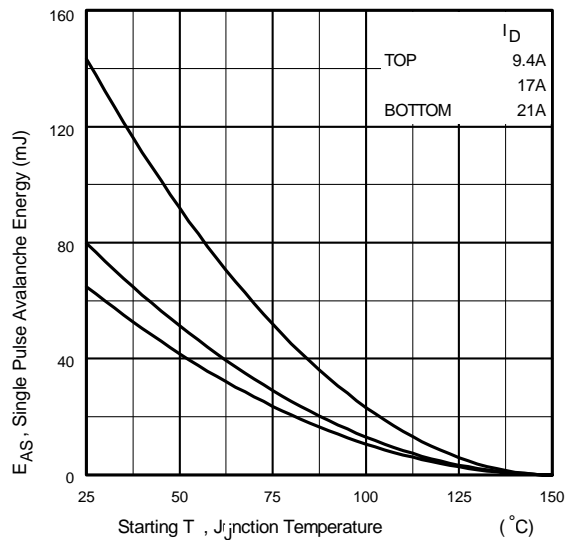
**Fig 12.** On-Resistance Vs. Drain Current



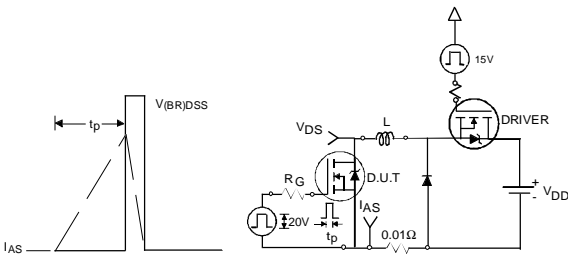
**Fig 13.** On-Resistance Vs. Gate Voltage



**Fig 13a&b.** Basic Gate Charge Test Circuit and Waveform

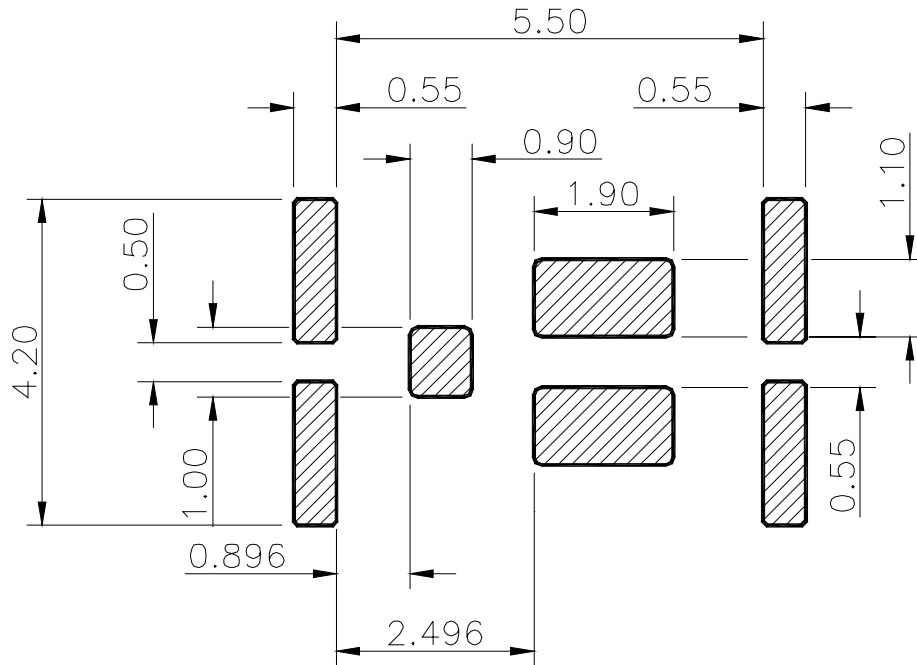


**Fig 14c.** Maximum Avalanche Energy Vs. Drain Current

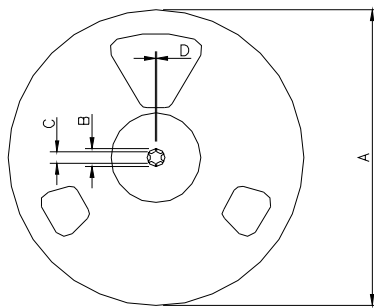
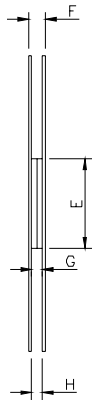


**Fig 14a&b.** Unclamped Inductive Test circuit and Waveforms

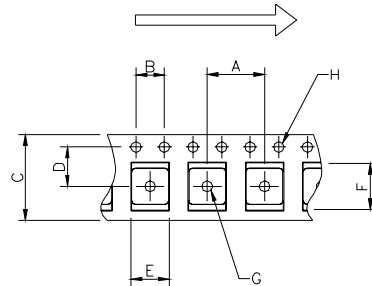
DirectFET™ Board Footprint



DirectFET™ Tape and Reel Dimension



Loaded Tape Feed Direction



Note: Controlling dimensions are in mm

CODE	DIMENSIONS		DIMENSIONS	
	MIN	MAX	MIN	MAX
A	330.0	N.C	12.992	N.C
B	20.2	N.C	0.795	N.C
C	12.8	13.2	0.504	0.520
D	1.5	N.C	0.059	N.C
E	100.0	N.C	3.937	N.C
F	N.C	18.4	N.C	0.724
G	12.4	14.4	0.488	0.567
H	11.9	15.4	0.469	0.606

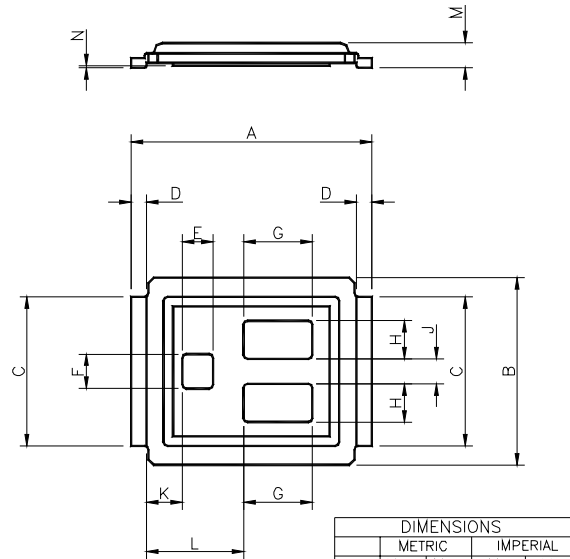
Note: Controlling dimensions in mm

CODE	DIMENSIONS		DIMENSIONS	
	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

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## DirectFET™ Outline Dimension



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	0.201
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

### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Pulse width  $\leq 400\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- ③ Surface mounted on 1 in square Cu board
- ④ Used double sided cooling, mounting pad
- ⑤ Mounted on minimum footprint full size board with metalized back and with small clip heatsink
- ⑥  $T_C$  measured with thermal couple mounted to top (Drain) of part.
- ⑦ Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.30\text{mH}$ ,  $R_G = 25\text{W}$ ,  $I_{AS} = 21\text{A}$ . (See Figure 14)

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.

International  
**IR** Rectifier

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TAC Fax: (310) 252-7903

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