International Rectifier

StrongIRFET™

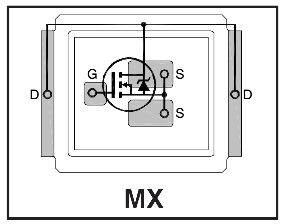
IRF7946PbF

DirectFET® Power MOSFET

V_{DSS}		40V
$R_{DS(on)}$	typ.	1.1mΩ
	max.	1.4mΩ
I_D (Silicon Limited)		198A①
I_D (Package Limited)		90A

Applications

- Brushed Motor drive applications
- BLDC Motor drive applications
- Battery powered circuits
- Half-bridge and full-bridge topologies
- Synchronous rectifier applications
- Resonant mode power supplies
- OR-ing and redundant power switches
- DC/DC and AC/DC converters
- DC/AC Inverters



Benefits

- Improved Gate, Avalanche and Dynamic dV/dt Ruggedness
- Fully Characterized Capacitance and Avalanche SOA
- Enhanced body diode dV/dt and dI/dt Capability
- RoHS Compliant Containing no Lead, no Bromide and no Halogen

Ordering Information

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
IRF7946TRPbF	DirectFET MX	Tape and Reel	4800	IRF7946TRPbF
IRF7946TR1PbF	DirectFET MX	Tape and Reel	1000	IRF7946TR1PbF

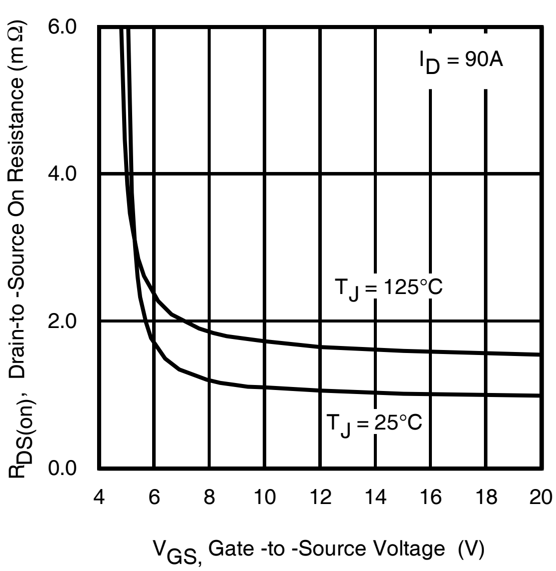


Fig 1. Typical On-Resistance vs. Gate Voltage

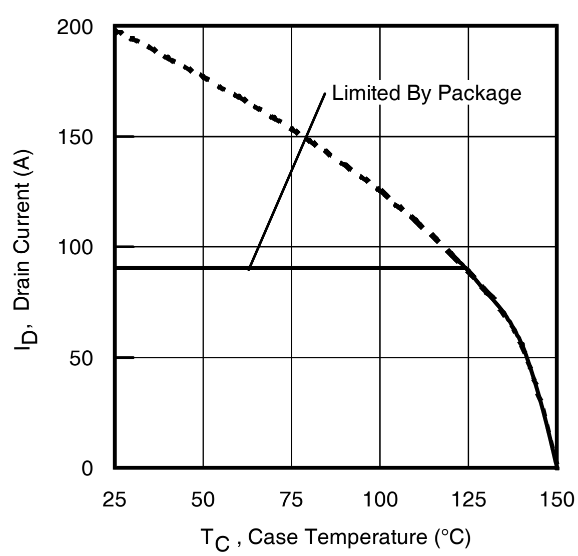


Fig 2. Maximum Drain Current vs. Case Temperature

Absolute Maximum Ratings

Symbol	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)	198①	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)	125①	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Package Limited)	90	
I_{DM}	Pulsed Drain Current ②	793	
P_D @T_C = 25°C	Maximum Power Dissipation	96	W
	Linear Derating Factor	0.77	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 150	°C

Avalanche Characteristics

$E_{AS\ (Thermally\ limited)}$	Single Pulse Avalanche Energy ③	85	mJ
$E_{AS\ (tested)}$	Single Pulse Avalanche Energy Tested Value ⑩	163	
I_{AR}	Avalanche Current ②	See Fig. 14, 15, 22a, 22b	A
E_{AR}	Repetitive Avalanche Energy ②		mJ

Thermal Resistance

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient ❶	–––	55	°C/W
$R_{\theta JA}$	Junction-to-Ambient ❸	12.5	–––	
$R_{\theta JA}$	Junction-to-Ambient ❷	20	–––	
$R_{\theta JC}$	Junction-to-Case ❹⑨	–––	1.3	
$R_{\theta JA-PCB}$	Junction-to-PCB Mounted	1.0	–––	

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

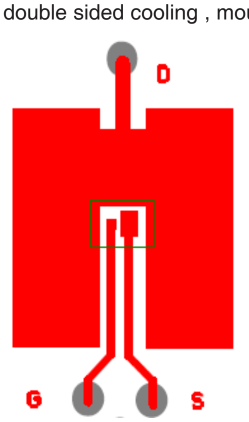
Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	40	–––	–––	V	V_{GS} = 0V, I_D = 250μA
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	–––	0.03	–––	V/°C	Reference to 25°C, I_D = 1.0mA②
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	–––	1.1	1.4	mΩ	V_{GS} = 10V, I_D = 90A ⑤
			1.7	–––	mΩ	V_{GS} = 6.0V, I_D = 72A ⑤
$V_{GS(th)}$	Gate Threshold Voltage	2.2	3.0	3.9	V	V_{DS} = V_{GS}, I_D = 150μA
I_{DSS}	Drain-to-Source Leakage Current	–––	–––	1.0	μA	V_{DS} = 40V, V_{GS} = 0V
		–––	–––	150		V_{DS} = 40V, 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
R_G	Internal Gate Resistance	–––	0.67	–––	Ω	

Notes:

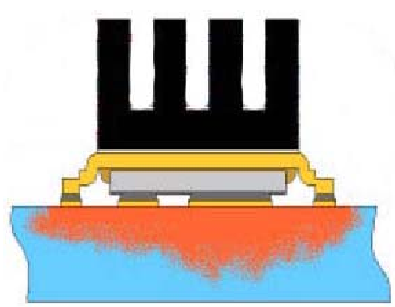
❷ Mounted on minimum footprint full size board with metalized back and with small clip heatsink.

❸ Used double sided cooling , mounting pad with large heatsink.

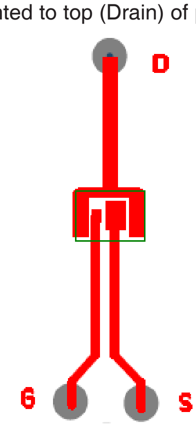
❹ T_C measured with thermocouple mounted to top (Drain) of part.



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



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

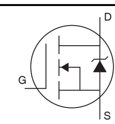


❷ Mounted on minimum footprint full size board with metalized back and with small clip heatsink (still air)

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
gfs	Forward Transconductance	91	–––	–––	S	V_{DS} = 10V, I_D = 90A
Q_g	Total Gate Charge	–––	141	212	nC	I_D = 90A
Q_{gs}	Gate-to-Source Charge	–––	36	–––		V_{DS} =20V
Q_{gd}	Gate-to-Drain ("Miller") Charge	–––	44	–––		V_{GS} = 10V ⑤
Q_{sync}	Total Gate Charge Sync. (Q_g - Q_{gd})	–––	97	–––		I_D = 90A, V_{DS} =0V, V_{GS} = 10V
$t_{d(on)}$	Turn-On Delay Time	–––	20	–––	ns	V_{DD} = 20V
t_r	Rise Time	–––	49	–––		I_D = 30A
$t_{d(off)}$	Turn-Off Delay Time	–––	54	–––		R_G = 2.7Ω
t_f	Fall Time	–––	41	–––		V_{GS} = 10V ⑤
C_{iss}	Input Capacitance	–––	6852	–––	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	–––	1046	–––		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	–––	735	–––		ƒ = 1.0 MHz
C_{oss} eff. (ER)	Effective Output Capacitance (Energy Related)	–––	1307	–––		V_{GS} = 0V, V_{DS} = 0V to 32V ⑦
C_{oss} eff. (TR)	Effective Output Capacitance (Time Related)	–––	1465	–––		V_{GS} = 0V, V_{DS} = 0V to 32V ⑥

Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	–––	–––	96①	A	MOSFET symbol showing the 
I_{SM}	Pulsed Source Current (Body Diode) ②	–––	–––	793	A	integral reverse p-n junction diode.
V_{SD}	Diode Forward Voltage	–––	0.75	1.2	V	T_J = 25°C, I_S = 90A, V_{GS} = 0V ⑤
dv/dt	Peak Diode Recovery ④	–––	1.6	–––	V/ns	T_J = 175°C, I_S = 90A, V_{DS} = 40V
t_{rr}	Reverse Recovery Time	–––	49	–––	ns	T_J = 25°C V_R = 34V,
		–––	50	–––		T_J = 125°C I_F = 90A
Q_{rr}	Reverse Recovery Charge	–––	74	–––	nC	T_J = 25°C di/dt = 100A/μs ⑤
		–––	73	–––		T_J = 125°C
I_{RRM}	Reverse Recovery Current	–––	2.6	–––	A	T_J = 25°C

Notes:

① Calculated continuous current based on maximum allowable junction temperature. Bond wire current limit is 90A. Note that current limitations arising from heating of the device leads may occur with some lead mounting arrangements. (Refer to AN-1140)

② Repetitive rating; pulse width limited by max. junction temperature.

③ Limited by T_{Jmax}, starting T_J = 25°C, L = 0.021mH R_G = 50Ω, I_{AS} = 90A, V_{GS} =10V.

④ I_{SD} ≤ 90A, di/dt ≤ 1135A/μs, V_{DD} ≤ $V_{(BR)DSS}$, T_J ≤ 150°C.

⑤ Pulse width ≤ 400μs; duty cycle ≤ 2%.

⑥ C_{oss} eff. (TR) is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

⑦ C_{oss} eff. (ER) is a fixed capacitance that gives the same energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

⑧ When mounted on 1" square PCB (FR-4 or G-10 Material). For recom mended footprint and soldering techniques refer to application note #AN-994.

⑨ R_θ is measured at T_J approximately 90°C.

⑩ This value determined from sample failure population, starting T_J = 25°C, L= 0.021mH, R_G = 50Ω, I_{AS} = 90A, V_{GS} =10V.

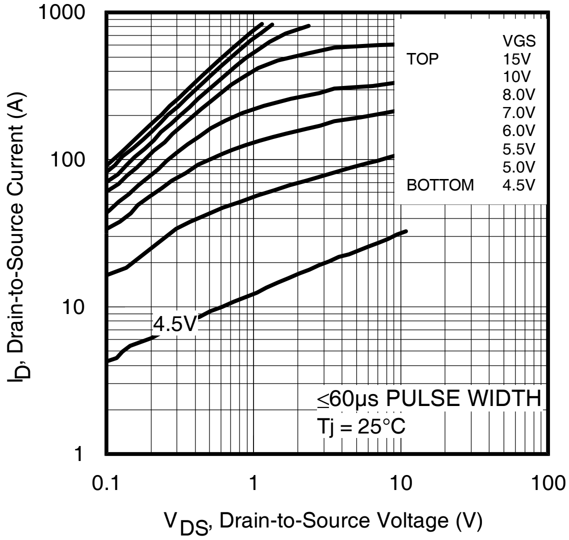


Fig 3. Typical Output Characteristics

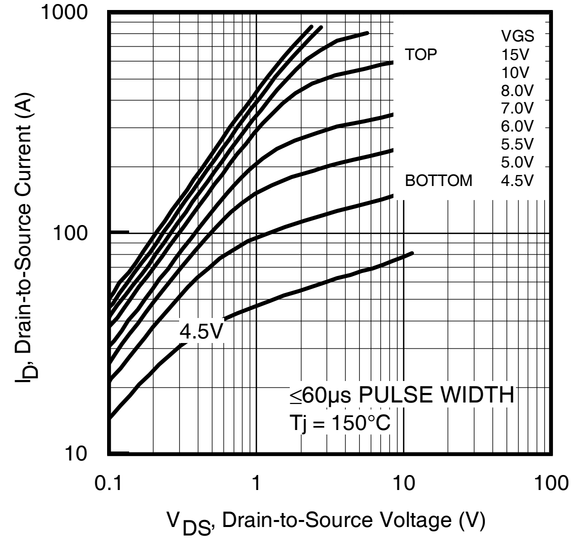


Fig 4. Typical Output Characteristics

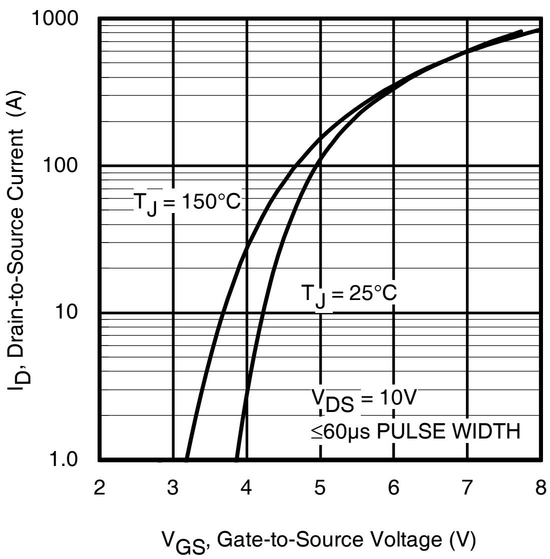


Fig 5. Typical Transfer Characteristics

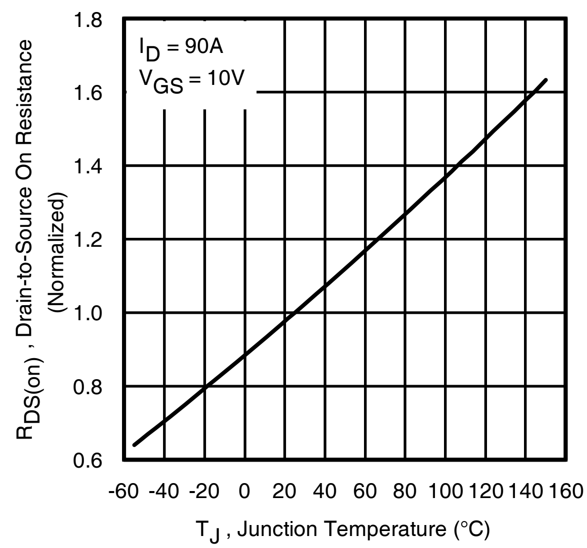


Fig 6. Normalized On-Resistance vs. Temperature

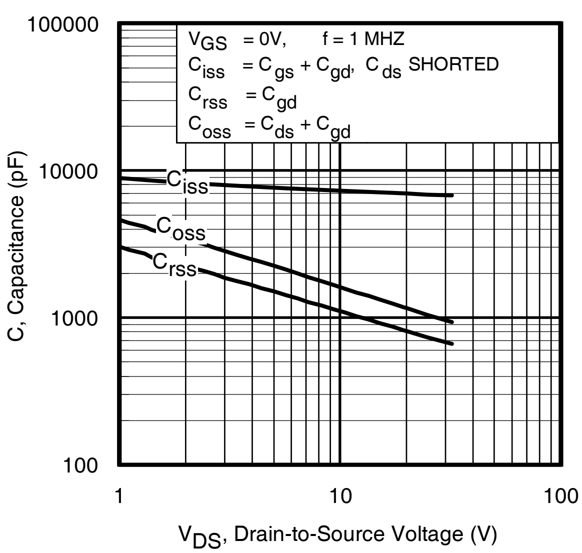


Fig 7. Typical Capacitance vs. Drain-to-Source Voltage

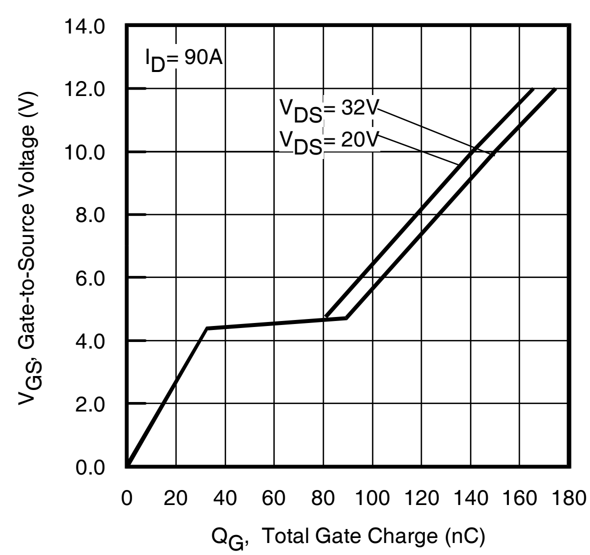


Fig 8. Typical Gate Charge vs. Gate-to-Source Voltage

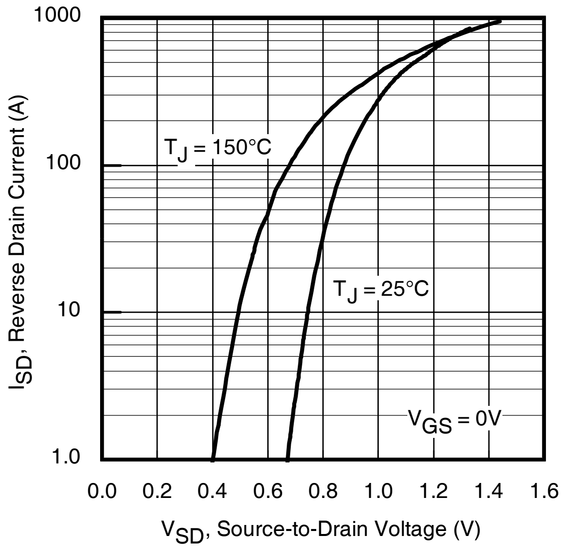


Fig 9. Typical Source-Drain Diode Forward Voltage

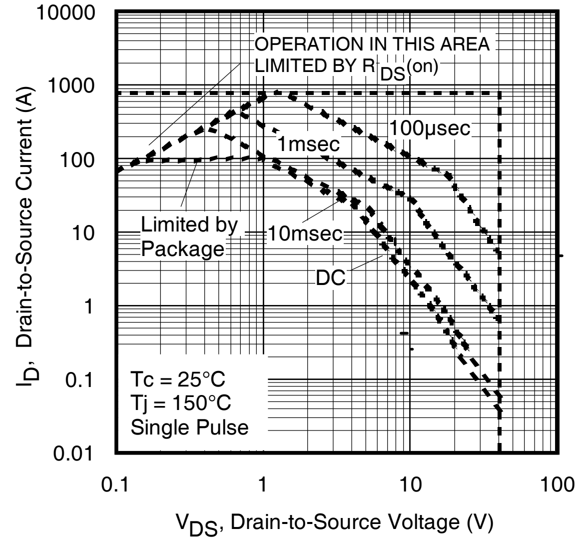


Fig 10. Maximum Safe Operating Area

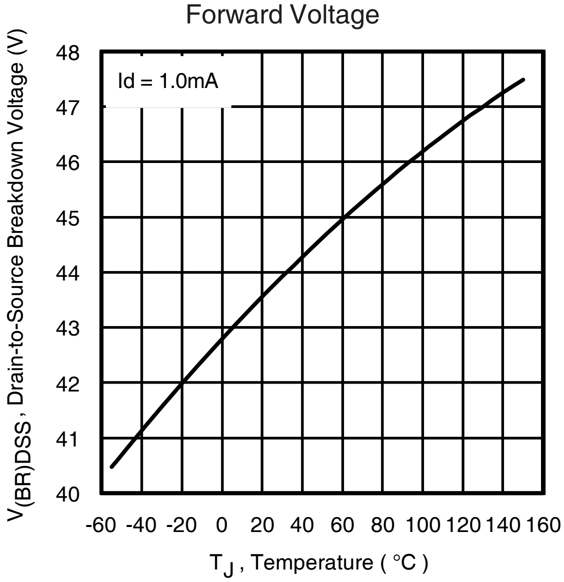


Fig 11. Drain-to-Source Breakdown Voltage

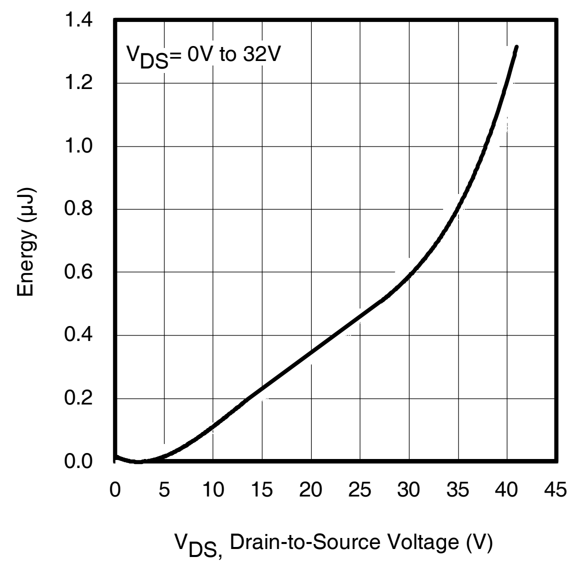


Fig 12. Typical C_{OSS} Stored Energy

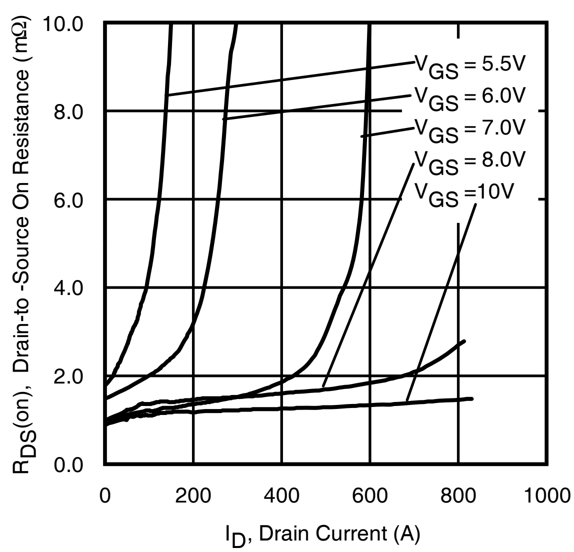


Fig 13. Typical On-Resistance vs. Drain Current

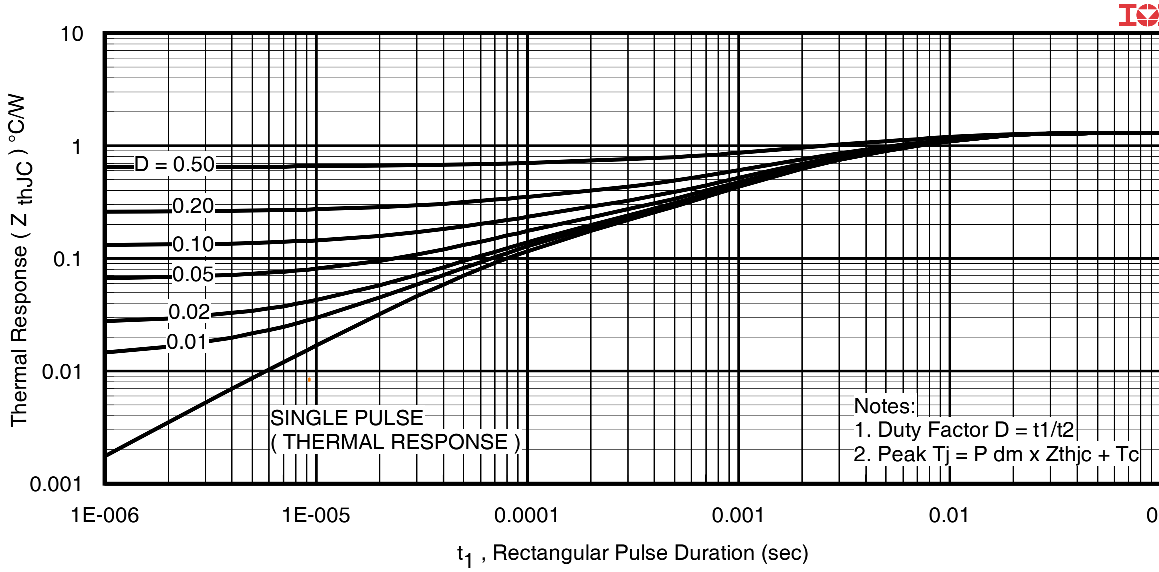


Fig 14. Maximum Effective Transient Thermal Impedance, Junction-to-Case

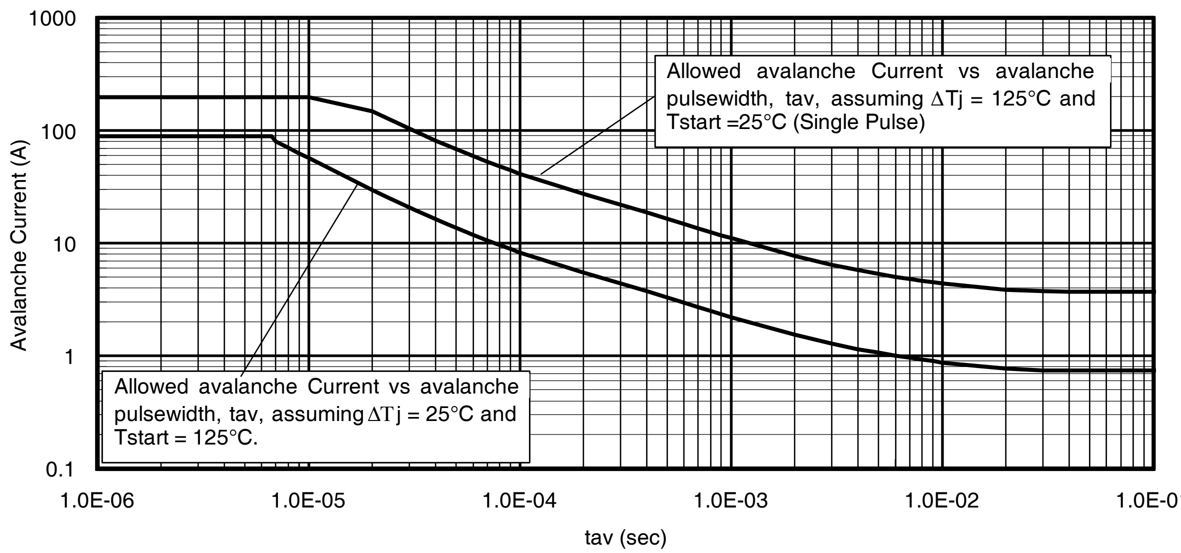


Fig 15. Typical Avalanche Current vs.Pulsewidth

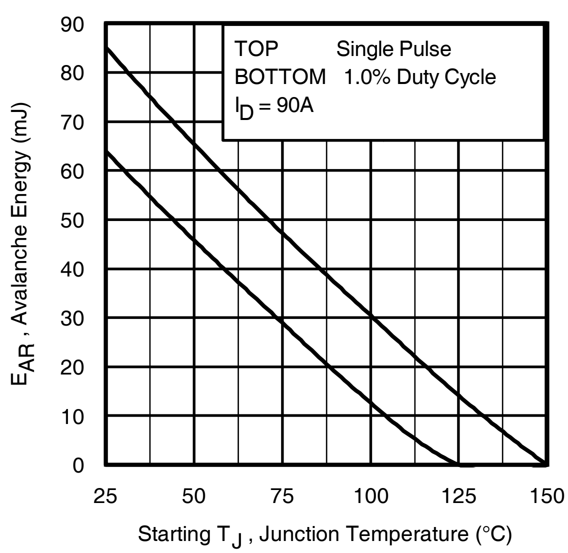


Fig 16. Maximum Avalanche Energy vs. Temperature

Notes on Repetitive Avalanche Curves , Figures 14, 15:
(For further info, see AN-1005 at www.irf.com)

1. Avalanche failures assumption:
   Purely a thermal phenomenon and failure occurs at a temperature far in excess of T_{jmax}. This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as T_{jmax} is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 16a, 16b.
4. $P_{D\ (ave)}$ = Average power dissipation per single avalanche pulse.
5. BV = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6. I_{av} = Allowable avalanche current.
7. ΔT = Allowable rise in junction temperature, not to exceed T_{jmax} (assumed as 25°C in Figure 14, 15).
   t_{av} = Average time in avalanche.
   D = Duty cycle in avalanche = $t_{av} \cdot f$
   $Z_{thJC}(D, t_{av})$ = Transient thermal resistance, see Figures 13)

$$P_{D\ (ave)} = 1/2\ (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$
$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$
$$E_{AS\ (AR)} = P_{D\ (ave)} \cdot t_{av}$$

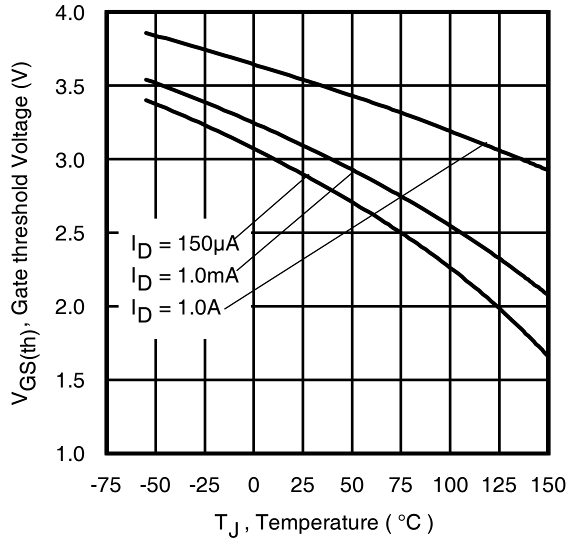


Fig 17. Threshold Voltage vs. Temperature

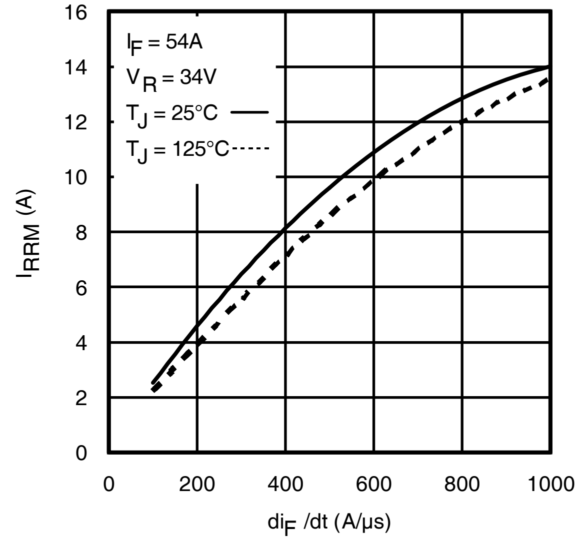


Fig. 18 - Typical Recovery Current vs. di_f/dt

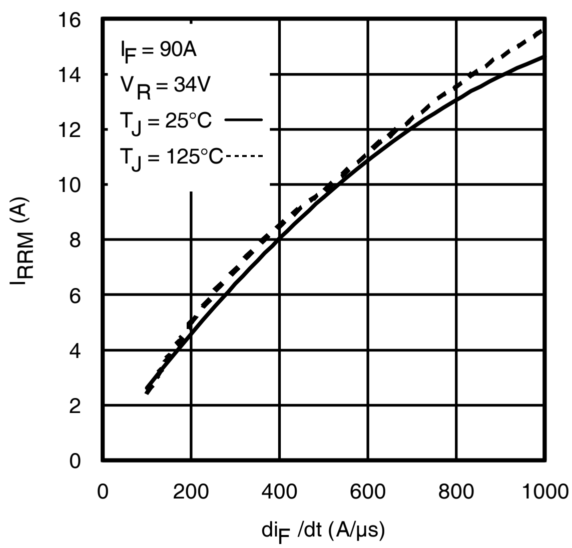


Fig. 19 - Typical Recovery Current vs. di_f/dt

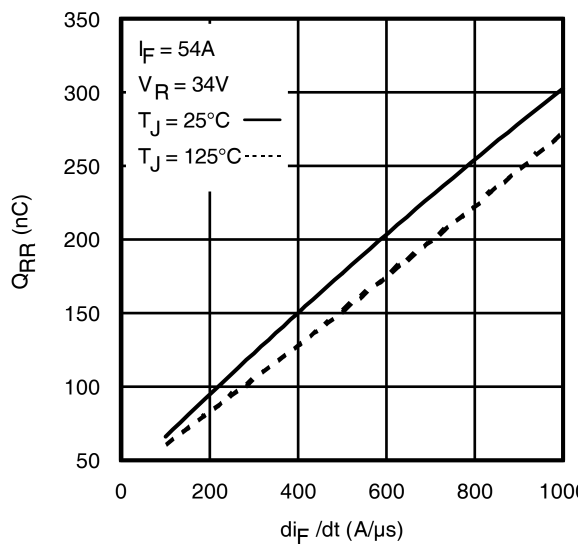


Fig. 20 - Typical Stored Charge vs. di_f/dt

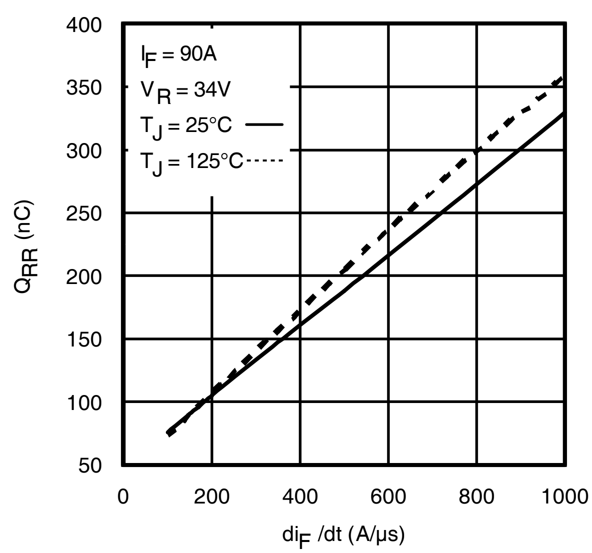


Fig. 21 - Typical Stored Charge vs. di_f/dt

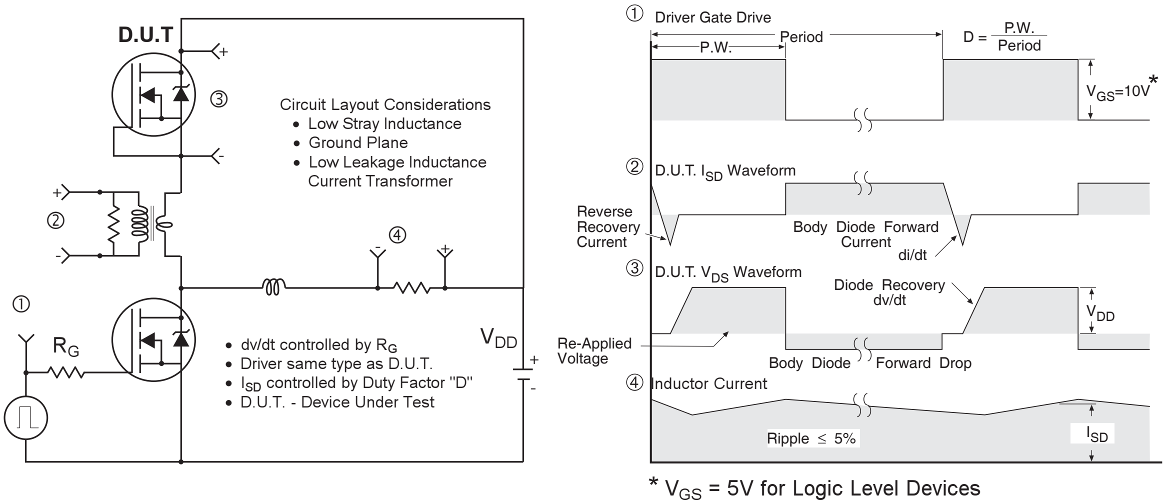


Fig 22. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

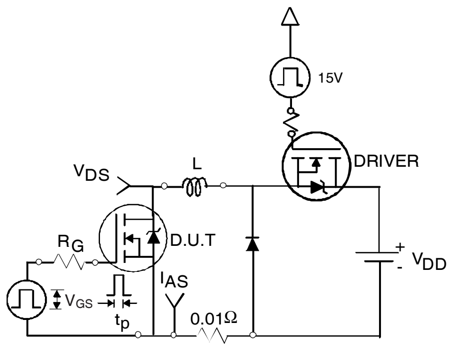


Fig 22a. Unclamped Inductive Test Circuit

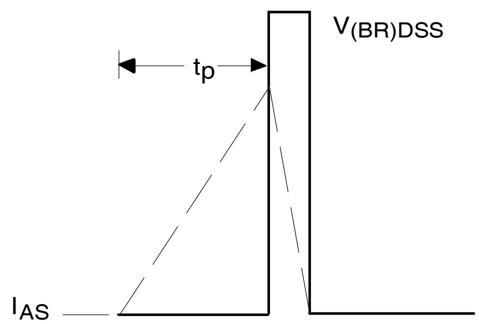


Fig 22b. Unclamped Inductive Waveforms

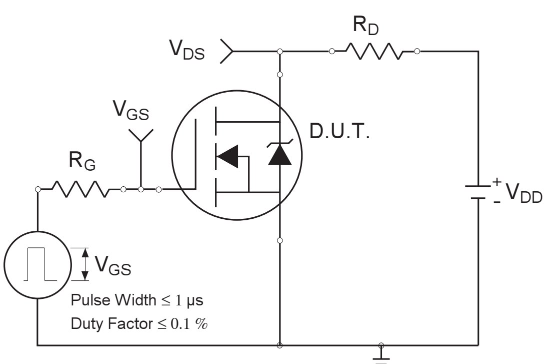


Fig 23a. Switching Time Test Circuit

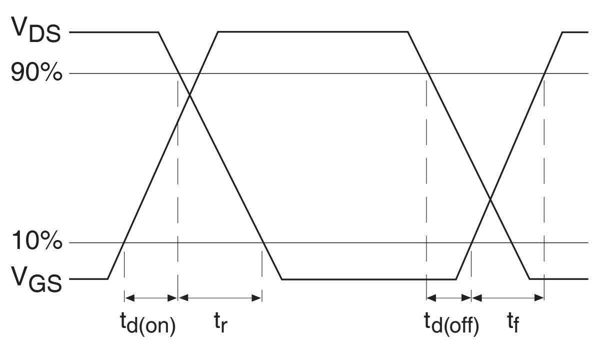


Fig 23b. Switching Time Waveforms

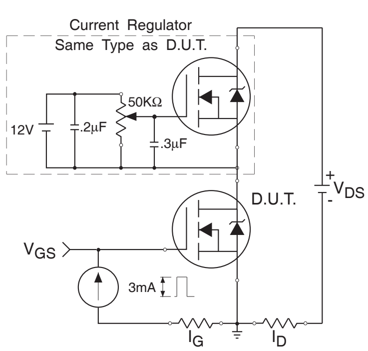


Fig 24a. Gate Charge Test Circuit

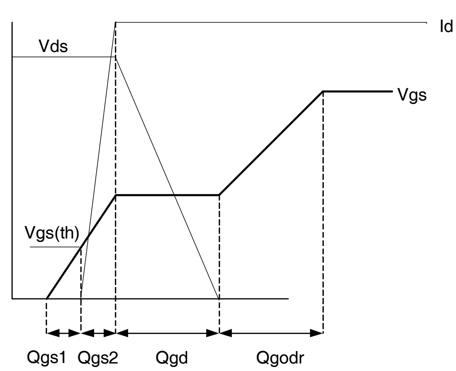
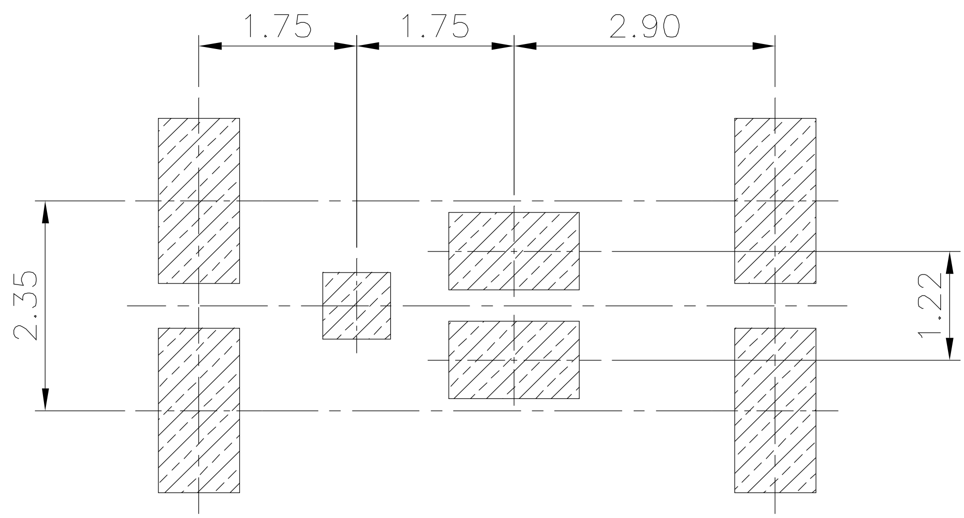


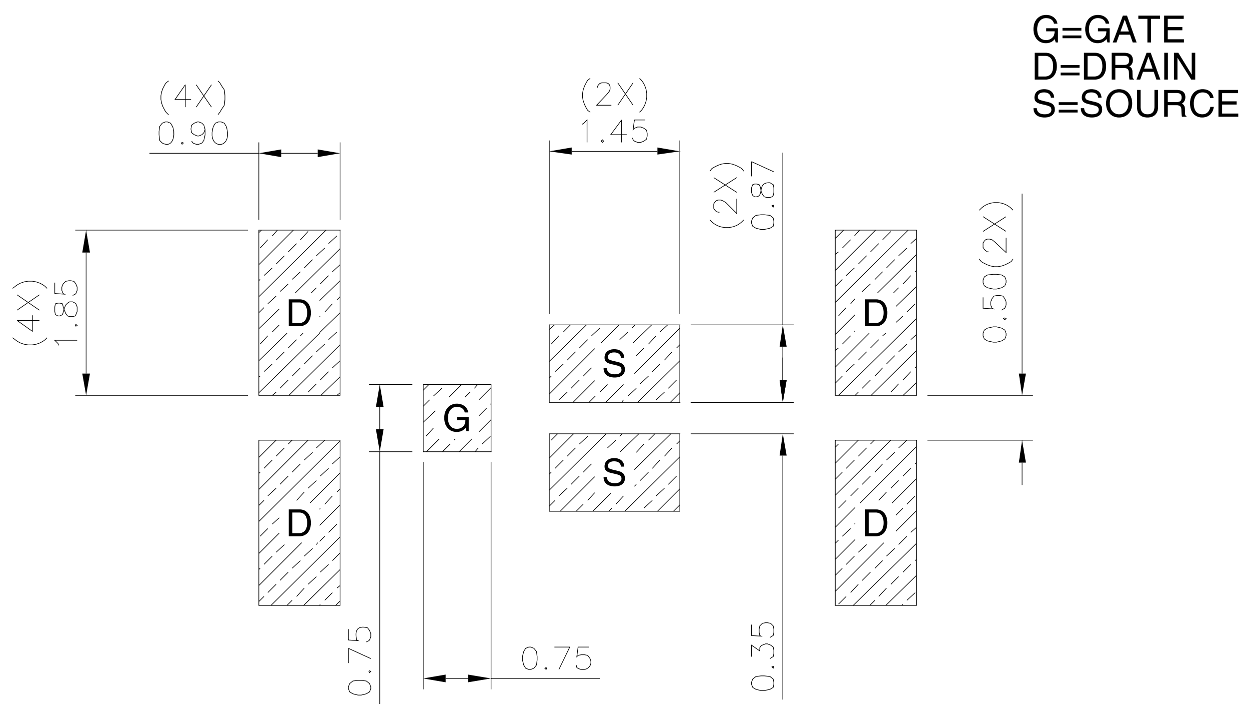
Fig 24b. Gate Charge Waveform

DirectFET® Board Footprint, 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.

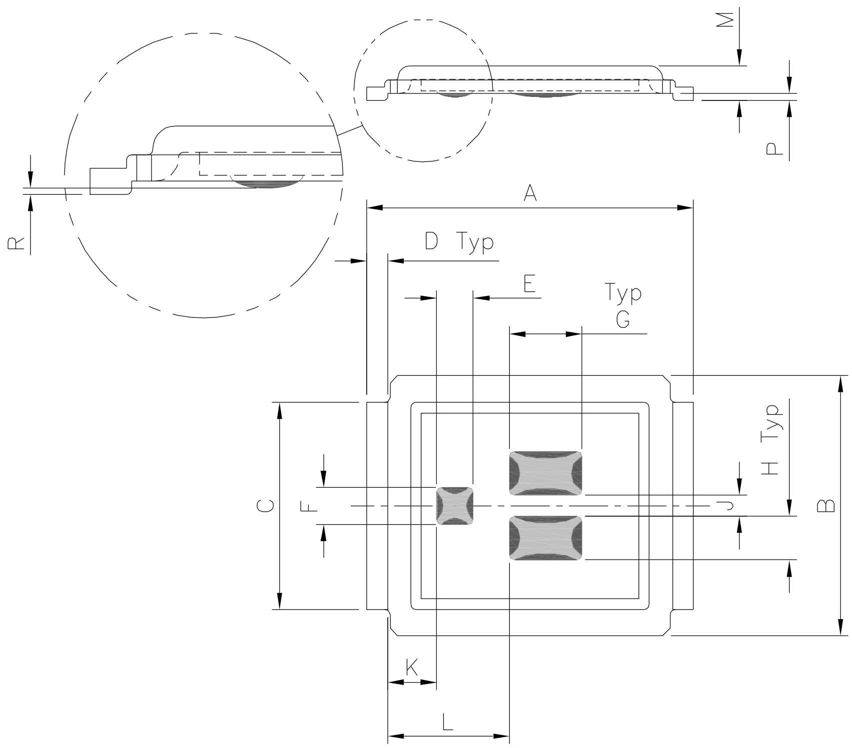




Note: For the most current drawing please refer to IR website at: http://www.irf.com/package/

DirectFET® Outline Dimension, MX Outline (Medium Size Can, X-Designation).

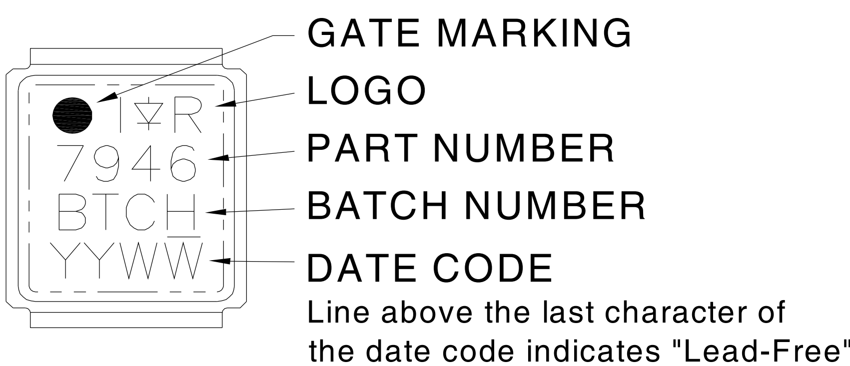
Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET. This includes all recommendations for stencil and substrate designs.



DIMENSIONS				
	METRIC		IMPERIAL	
CODE	MIN	MAX	MIN	MAX
A	6.25	6.35	0.246	0.250
B	4.80	5.05	0.189	0.199
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	0.031	0.033
J	0.38	0.42	0.015	0.017
K	0.88	1.02	0.035	0.040
L	2.28	2.42	0.090	0.095
M	0.59	0.70	0.023	0.028
R	0.03	0.08	0.001	0.003
P	0.08	0.17	0.003	0.007

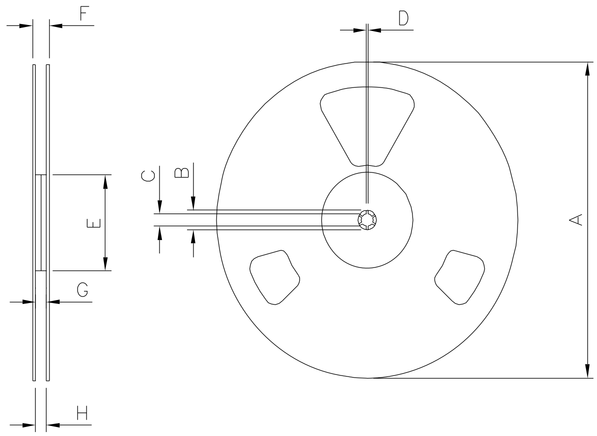
Dimensions are shown in millimeters (inches)

DirectFET® Part Marking



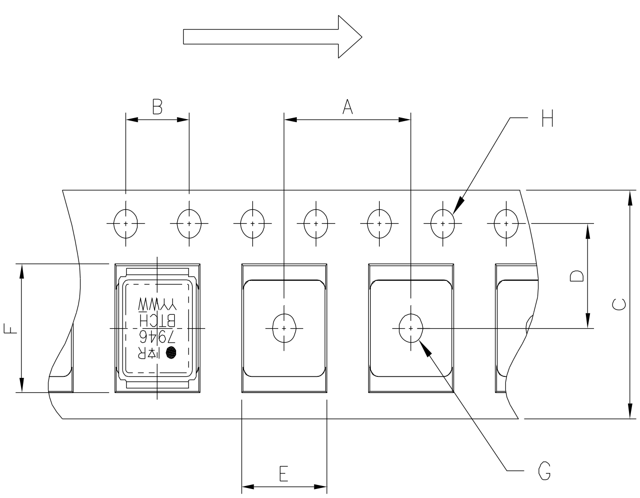
Note: For the most current drawing please refer to IR website at: http://www.irf.com/package/

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



NOTE: Controlling dimensions in mm
Std reel quantity is 4800 parts. (ordered as IRF7946TRPBF). For 1000 parts on 7" reel, order IRF7946TR1PBF

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



NOTE: CONTROLLING DIMENSIONS IN MM

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

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	DFET 1.5	MSL3 (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/

†† Higher qualification ratings may be available should the user have such requirements. Please contact your International Rectifier sales representative for further information: http:www.irf.com/whoto-call/salesrep/

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

Data and specifications subject to change without notice.

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