DirectFET™ dual P-Channel Power MOSFET ②

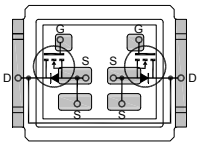
Typical values (unless otherwise specified)

V_{DSS}	V_{GS}	$R_{DS(on)}$	$R_{DS(on)}$
-30V max	±20V max	5.3mΩ@-10V	8.5mΩ@-4.5V

$Q_{g\ tot}$	Q_{gd}	Q_{gs2}	Q_{rr}	Q_{oss}	$V_{gs(th)}$
32nC	15nC	3.2nC	62nC	23nC	-1.8V

Applications
- Isolation Switch for Input Power or Battery Application

Features and Benefits
- Environmentally Friendly Product
- ROHS compliant, Halogen-Free
- Dual Common-Drain P-Channel MOSFETs Provides High Level of Integration and Very Low RDS(on)



MC


DirectFET™ ISOMETRIC

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

SQ	SX	ST		MQ	MX	MT	MP	**MC**		

Description

The IRF9394MTRPbF combines the latest HEXFET® P-Channel Power MOSFET Silicon technology with the advanced DirectFETTM packaging to achieve the lowest on-state resistance in a package that has the footprint of a SO-8 and only 0.54 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%

Orderable Part Number	Package Type	Standard Pack		Note
		Form	Quantity	
IRF9394MTRPbF	DirectFET Medium Can	Tape and Reel	4800	"TR" suffix

Absolute Maximum Ratings

Symbol	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	-14	A
I_D @ T_A = 70°C	Continuous Drain Current, V_{GS} @ 10V ③	-11	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V ③	-75	
I_{DM}	Pulsed Drain Current ①	-110	

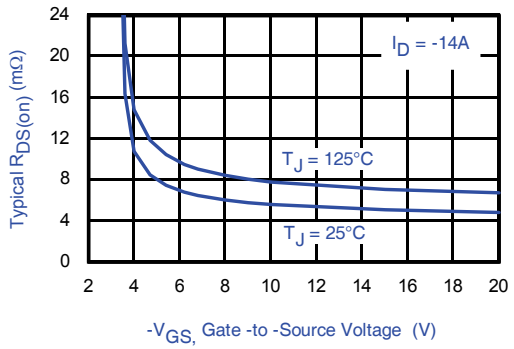


Fig 1. Typical On– Resistance vs. Gate Voltage

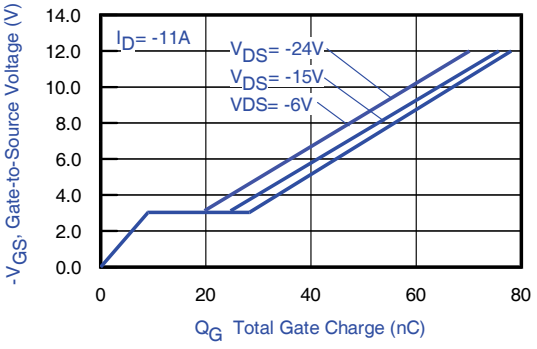


Fig 2. Typical Gate Charge vs. Gate-to-Source Voltage

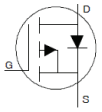
Notes:
① Click on this section to link to the appropriate technical paper.
② Click on this section to link to the DirectFET Website.
③ Surface mounted on 1 in. square Cu board, steady state.
④ TC measured with thermocouple mounted to top (Drain) of part.
⑤ Repetitive rating; pulse width limited by max. junction temperature.

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	-30	—	—	V	V_{GS} = 0V, I_D = -250µA
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.012	—	V/°C	Reference to 25°C, I_D = -1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	5.3	6.5	mΩ	V_{GS} = -10V, I_D = -14A ⑥
		—	8.5	10.2		V_{GS} = -4.5V, I_D = -11A ⑥
$V_{GS(th)}$	Gate Threshold Voltage	-1.3	-1.8	-2.4	V	V_{DS} = V_{GS}, I_D = -50µA
$\Delta V_{GS(th)}/\Delta T_J$	Gate Threshold Voltage Temp. Coefficient	—	-6.1	—		
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	40	—	—	S	V_{DS} = -15V, I_D = -11A
Q_g	Total Gate Charge	—	64	—	nC	V_{DS} = -15V,V_{GS} = -10V, I_D = -11A
Q_g	Total Gate Charge	—	32	—		V_{DS} =-15V V_{GS} = -4.5V I_D = -11A
Q_{gs1}	Pre -Vth Gate-to-Source Charge	—	6.5	—		
Q_{gs2}	Post-Vth Gate-to-Source Charge	—	3.2	—		
Q_{gd}	Gate-to-Drain Charge	—	15	—		
Q_{godr}	Gate Charge Overdrive	—	7.3	—		
Q_{sw}	Switch Charge (Q_{gs2} + Q_{gd})	—	18.2	—		
Q_{OSS}	Output Charge	—	23	—	nC	V_{DS} =-16V, V_{GS} = 0V
R_G	Gate Resistance	—	15	—	Ω	
$t_{d(on)}$	Turn-On Delay Time	—	16	—	ns	V_{DD} = -15V I_D = -11A R_G = 1.8Ω V_{GS} = -4.5V ⑥
t_r	Rise Time	—	142	—		
$t_{d(off)}$	Turn-Off Delay Time	—	76	—		
t_f	Fall Time	—	121	—		
C_{iss}	Input Capacitance	—	3241	—	pF	V_{GS} = 0V V_{DS} = -15V *f* = 1KHz
C_{oss}	Output Capacitance	—	820	—		
C_{rss}	Reverse Transfer Capacitance	—	466	—		

Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	—	—	-57	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ⑤	—	—	-110		
V_{SD}	Diode Forward Voltage	—	—	-1.2	V	T_J= 25°C,I_S =-11A, V_{GS} = 0V⑥
t_{rr}	Reverse Recovery Time	—	43	65	ns	T_J = 25° C ,V_R = -15V, I_F = -11A
Q_{rr}	Reverse Recovery Charge	—	62	93	nC	di/dt =260A/µs ⑥

Notes:
⑤ Repetitive rating; pulse width limited by max. junction temperature.
⑥ Pulse width ≤ 400µs; duty cycle ≤ 2%.

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Absolute Maximum Ratings

Symbol	Parameter	Max.	Units
P_D @T_A = 25°C	Maximum Power Dissipation ③	2.1	W
P_D @T_A = 70°C	Maximum Power Dissipation ③	1.3	
P_D @T_C = 25°C	Maximum Power Dissipation ④	57	
	Linear Dearating Factor③	0.02	W/°C
T_{JP}	Peak Soldering Temperature	270	°C
T_J T_{STG}	Operating Junction and Storage Temperature Range	-40 to + 150	

Thermal Resistance

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient ③	–––	60	°C/W
$R_{\theta JA}$	Junction-to-Ambient ⑦	12.5	–––	
$R_{\theta JA}$	Junction-to-Ambient ⑧	20	–––	
$R_{\theta JC}$	Junction-to-Case ④⑨	–––	2.2	
$R_{\theta JA\text{-}PCB}$	Junction-to-PCB Mounted	1.0	–––	

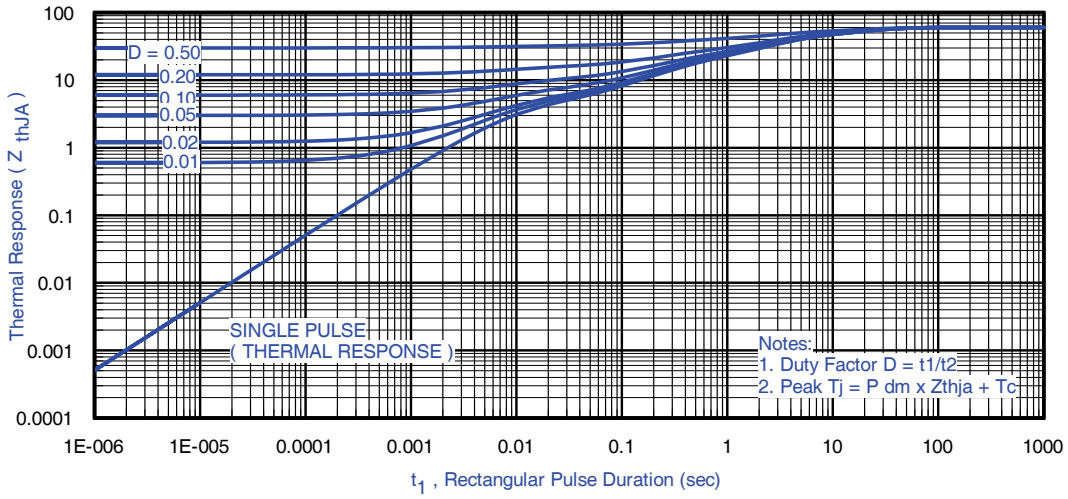
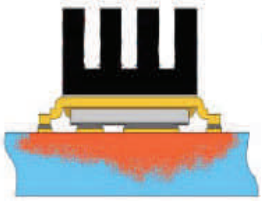


Fig 3. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient③

Notes:
③ Surface mounted on 1 in. square Cu board, steady state.
④ TC measured with thermocouple mounted to top (Drain) of part
⑦ Used double sided cooling, mounting pad with large heat sink.
⑧ Mounted on minimum footprint full size board with metalized back and with small clip heat sink.
⑨ R_θ is measured at T_J of approximately 90°C.



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



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



⑨ Mounted on minimum footprint full size board with metalized back and with small clip heatsink (still air)

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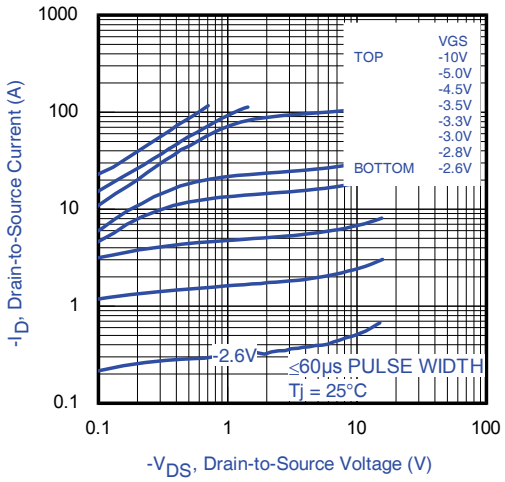


Fig 4. Typical Output Characteristics

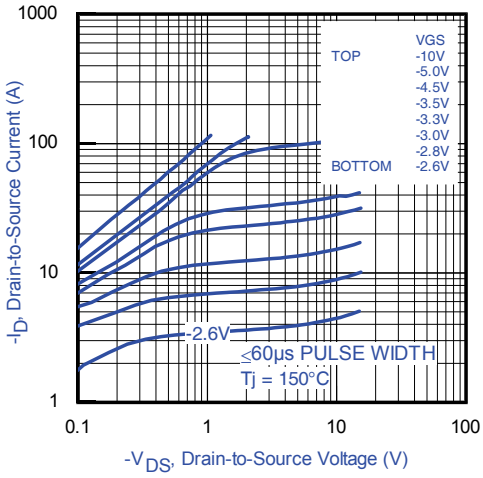


Fig 5. Typical Output Characteristics

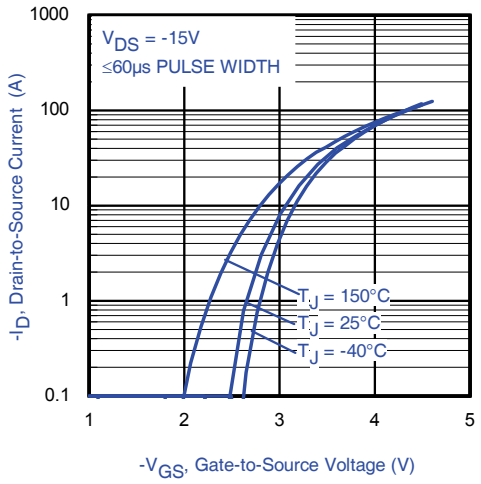


Fig 6. Typical Transfer Characteristics

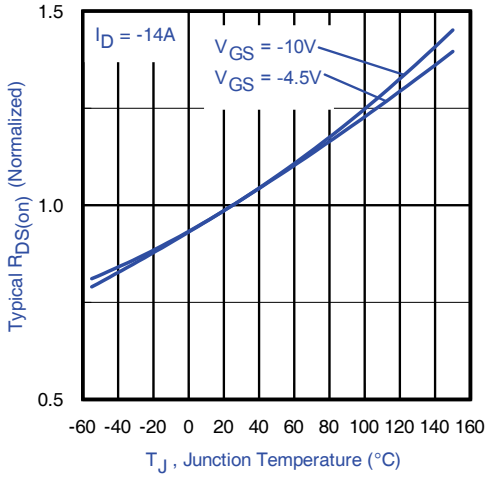


Fig 7. Normalized On-Resistance vs. Temperature

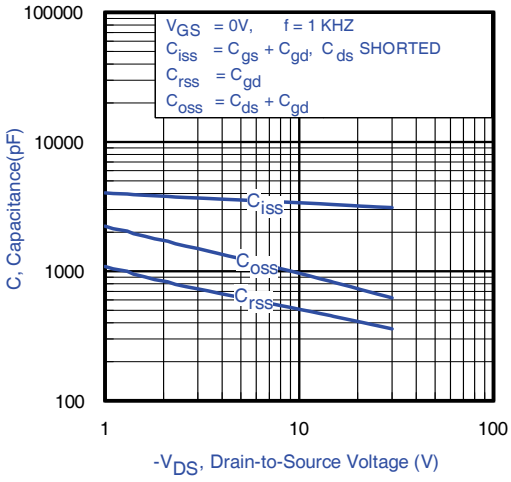


Fig 8. Typical Capacitance vs. Drain-to-Source Voltage

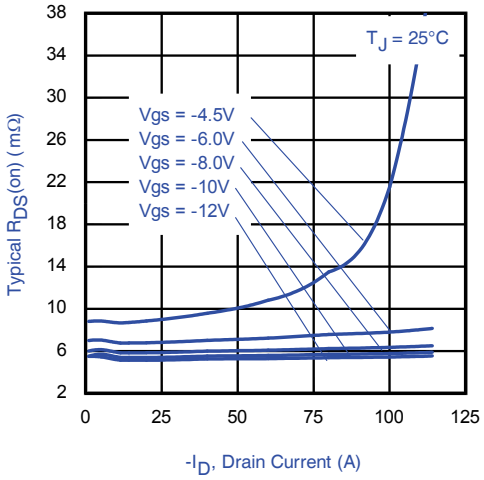


Fig 9. Typical On– Resistance vs. Drain Current

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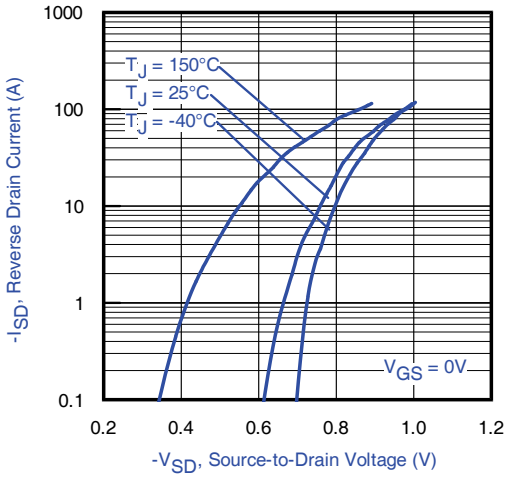


Fig 10. Typical Source-Drain Diode Forward Voltage

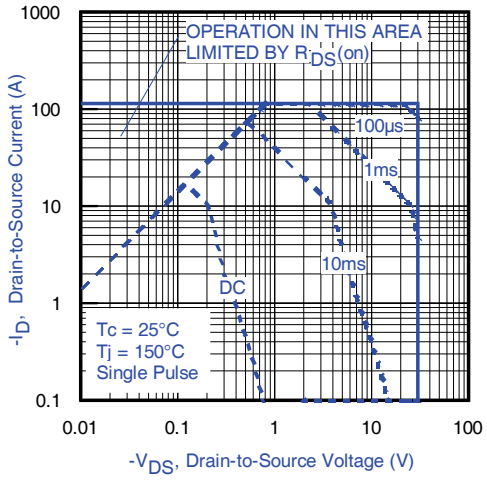


Fig 11. Maximum Safe Operating Area

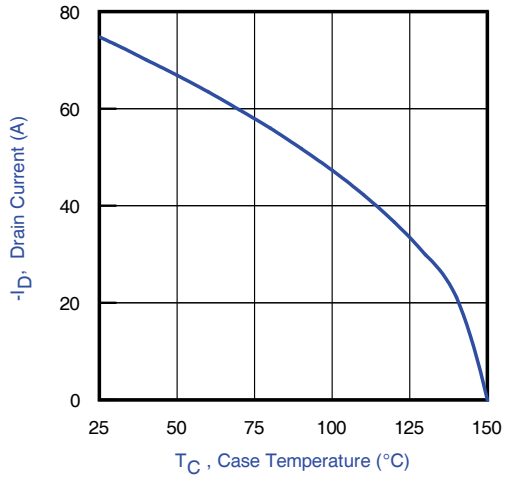


Fig 12. Maximum Drain Current vs. Case Temperature

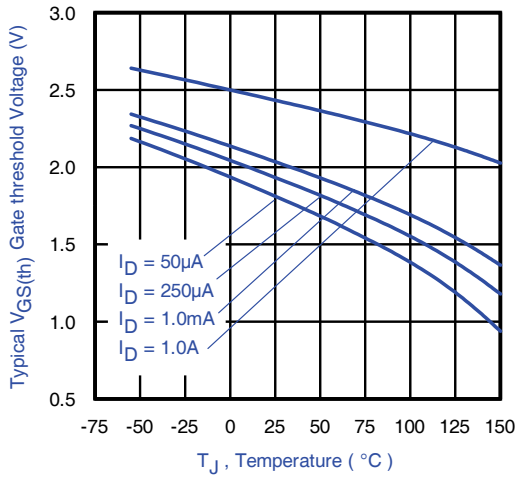


Fig 13. Threshold Voltage vs. Temperature

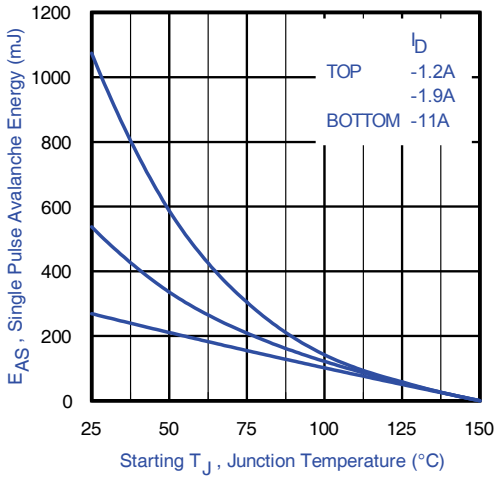


Fig 14. Maximum Avalanche Energy vs. Drain Current

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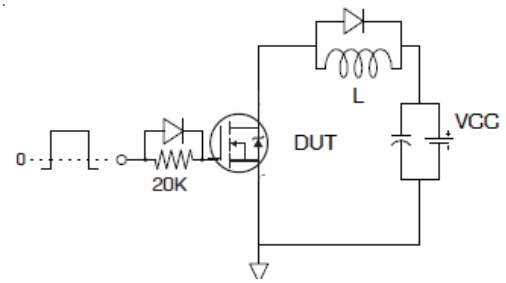


Fig 15a. Gate Charge Test Circuit

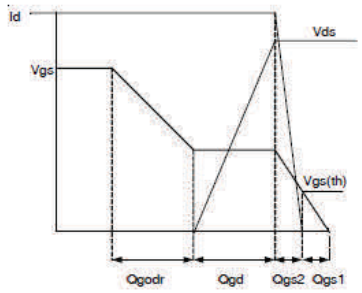


Fig 15b. Gate Charge Waveform

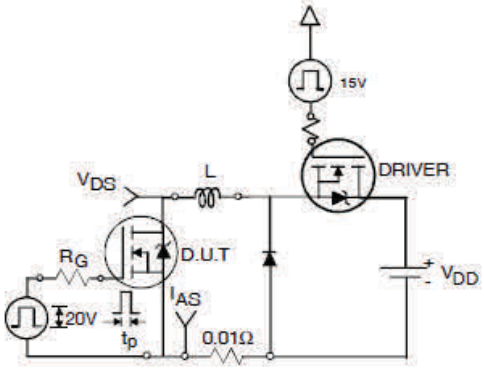


Fig 16a. Unclamped Inductive Test Circuit

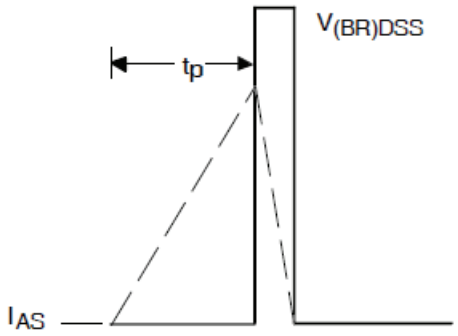


Fig 16b. Unclamped Inductive Waveforms

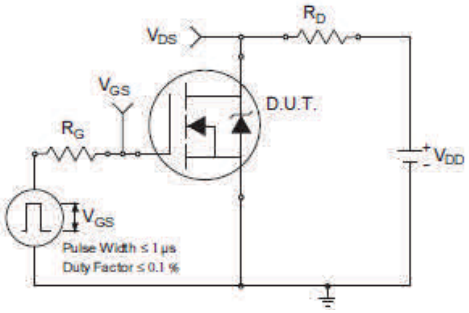


Fig 17a. Switching Time Test Circuit

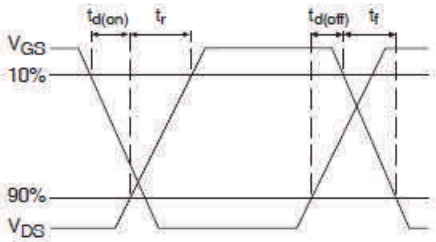
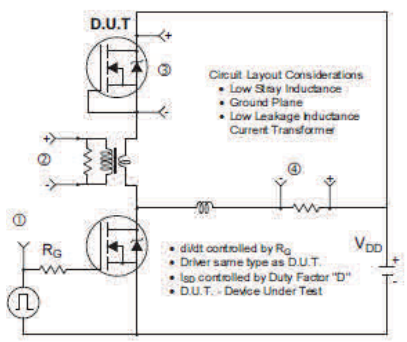


Fig 17b. Switching Time Waveforms



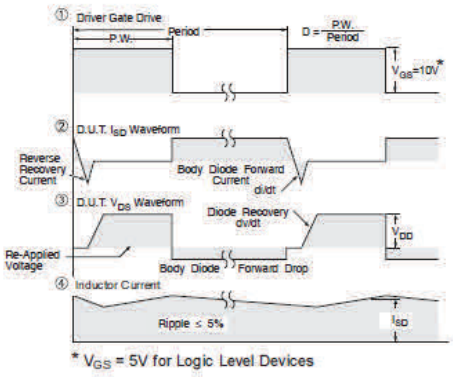
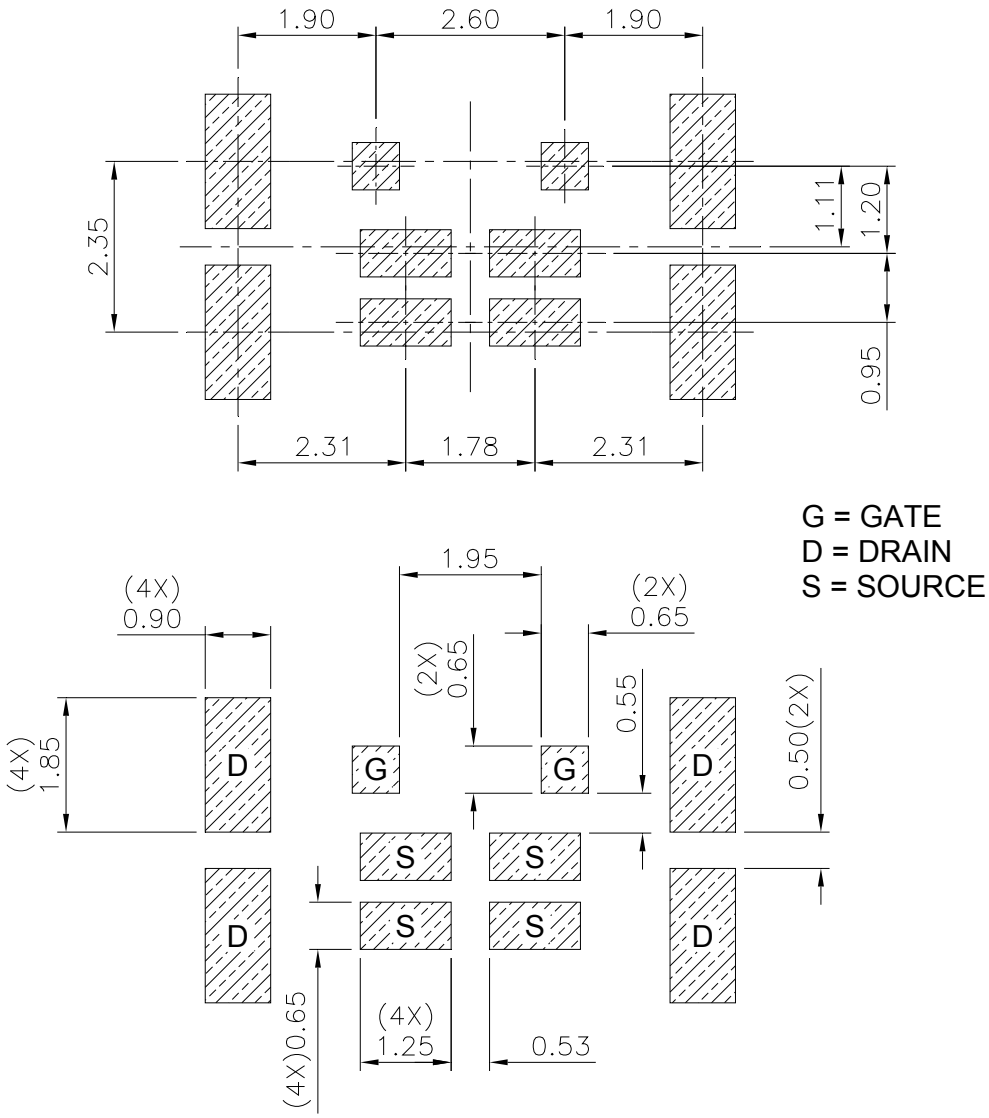


Fig 18. Diode Reverse Recovery Test Circuit for N-Channel HEXFET Power MOSFETs

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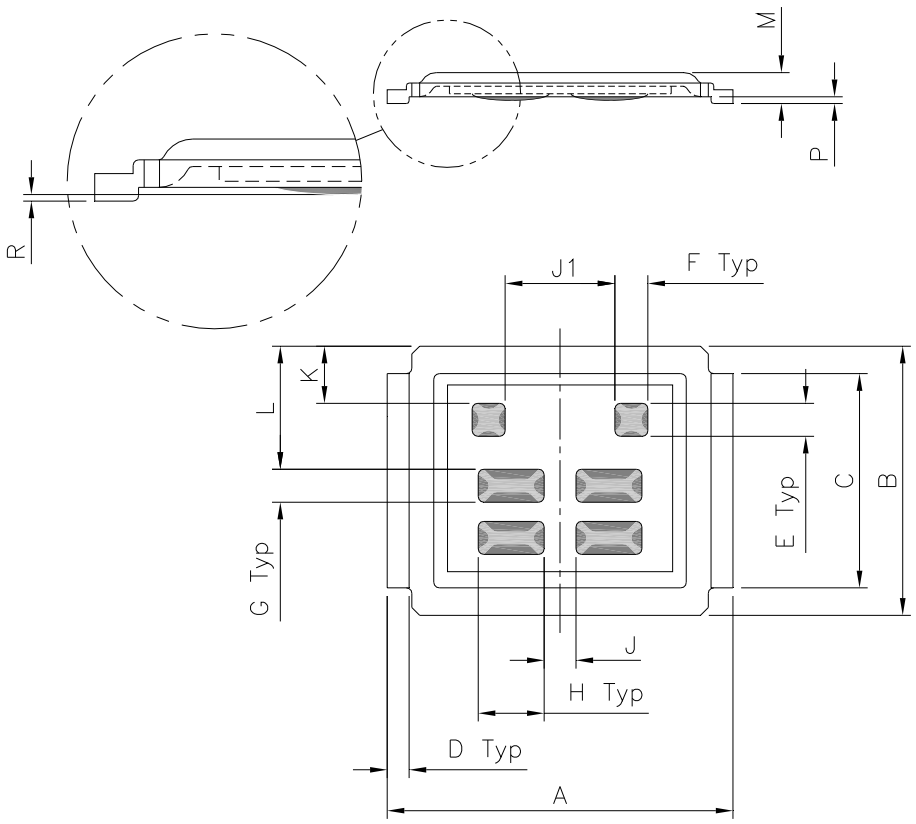
DirectFET™ Board Footprint, MC Outline
(Medium Size Can, C-Designation).
Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET.
This includes all recommendations for stencil and substrate designs.



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

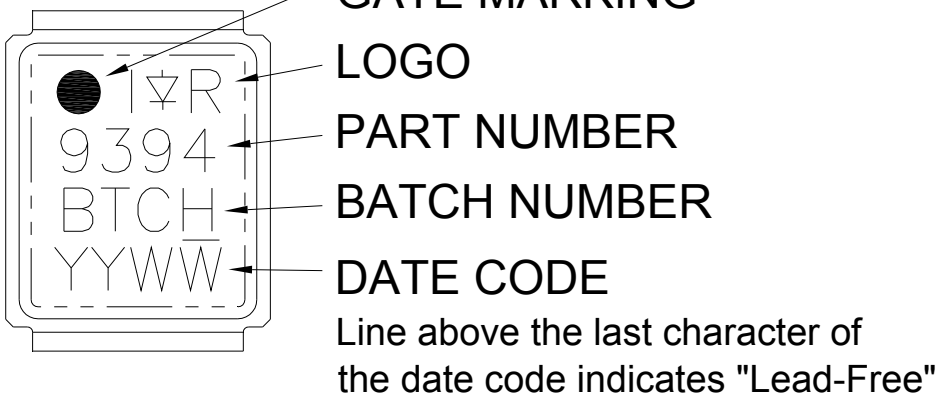
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DirectFET™ Outline Dimension, MC Outline
(Medium Size Can, C-Designation).
Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET. This includes all recommendations for stencil and substrate designs.



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	0.58	0.62	0.023	0.024
F	0.58	0.62	0.023	0.024
G	0.58	0.62	0.023	0.024
H	1.18	1.22	0.047	0.048
J	0.56	0.60	0.022	0.023
J1	1.98	2.02	0.078	0.079
K	0.975	1.105	0.038	0.043
L	2.175	2.305	0.086	0.091
M	0.535	0.595	0.021	0.023
R	0.02	0.08	0.0008	0.0031
P	0.08	0.17	0.003	0.007

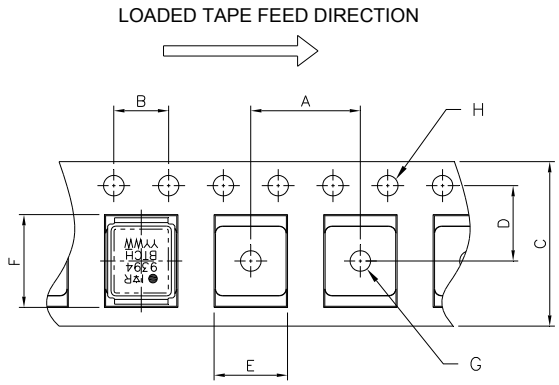
DirectFET™ Part Marking



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

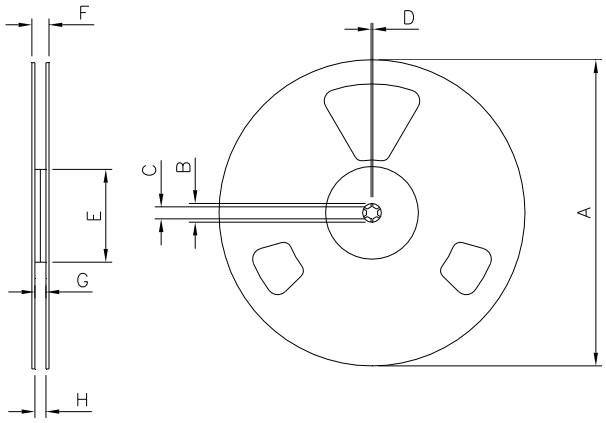
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DirectFET™ Tape & Reel Dimension (Showing component orientation).



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: Controlling dimensions in mm
Std reel quantity is 4800 parts (ordered as IRF9394MTRPBF).

REEL DIMENSIONS				
STANDARD OPTION **(QTY 4800)**				
	METRIC		IMPERIAL	
CODE	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: For the most current drawing please refer to IR website at http://www.irf.com/package/

Qualification Information†

Qualification Level	Industrial† (per JEDEC JESD47F†† guidelines)	
Moisture Sensitivity Level	DirectFET	MSL1 (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

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

International IOR Rectifier

IR WORLD HEADQUARTERS: 101 N. Sepulveda Blvd., El Segundo, California 90245, USA

To contact International Rectifier, please visit http://www.irf.com/whoto-call/

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