

DirectFET™ dual P-Channel Power MOSFET ②

Typical values (unless otherwise specified)

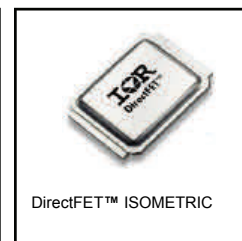
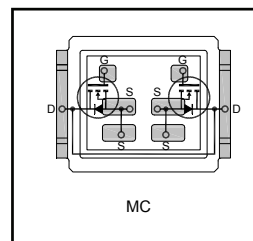
V_{DS}	V_{GS}	$R_{DS(on)}$	$R_{DS(on)}$		
-30V max	±20V max	5.3mΩ @ -10V	8.5mΩ @ -4.5V		
$Q_{g\ tot}$	Q_{gd}	Q_{gs2}	Q_{rr}	Q_{oss}	$V_{gs(th)}$
32nC	15nC	3.2nC	62nC	23nC	-1.8V

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)



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

SQ	SX	ST		MQ	MX	MT	MP	MC		
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Description

The IRF9394MTRPbF combines the latest HEXFET® P-Channel 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 0.54 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	V
$I_D @ T_A = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ ③	-14	A
$I_D @ T_A = 70^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ ③	-11	A
$I_D @ T_C = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ ③	-75	A
I_{DM}	Pulsed Drain Current ①	-110	A

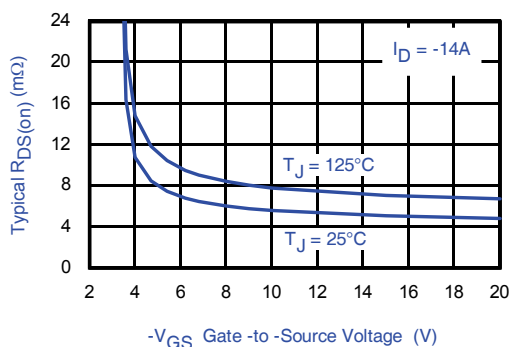


Fig 1. Typical On- Resistance vs. Gate Voltage

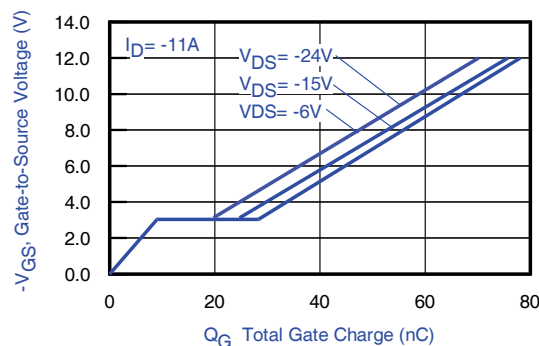


Fig 2. Typical Gate Charge vs. Gate-to-Source Voltage

Notes:

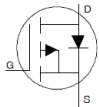
- ① Click on this section to link to the appropriate technical paper.
- ② Click on this section to link to the DirectFET Website.
- ③ Surface mounted on 1 in. square Cu board, steady state.

- ④ TC measured with thermocouple mounted to top (Drain) of part.
- ⑤ Repetitive rating; pulse width limited by max. junction temperature.

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
ΔV _{(BR)DSS} /ΔT _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
ΔV _{GS(th)} /ΔT _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
g _{fs}	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 V _{DS} = -15V V _{GS} = -4.5V I _D = -11A
Q _g	Total Gate Charge	—	32	—		
Q _{gs1}	Pre -V _{th} Gate-to-Source Charge	—	6.5	—		
Q _{gs2}	Post-V _{th} 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	—		
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} = 0V ⑥
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.

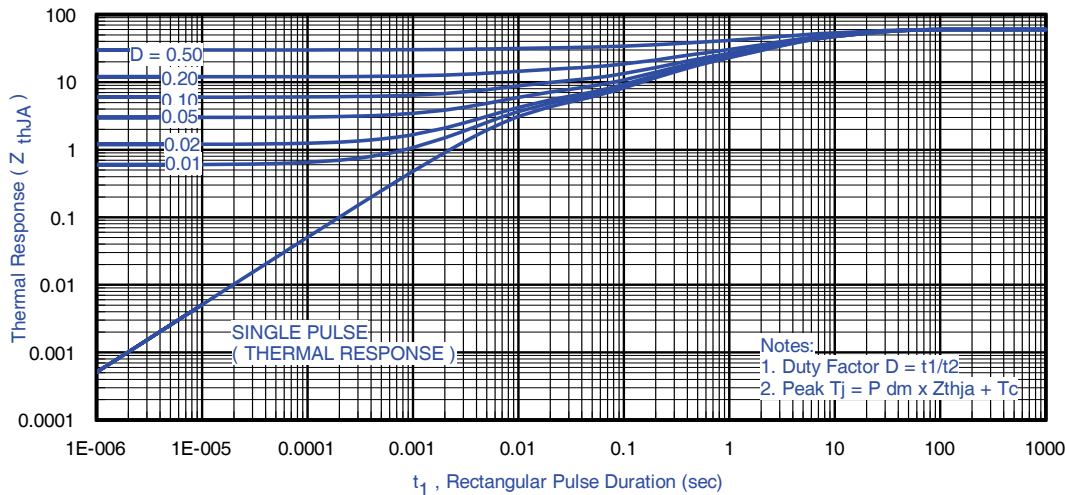
⑥ Pulse width ≤ 400μs; duty cycle ≤ 2%.

Absolute Maximum Ratings

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

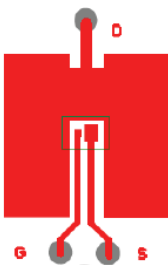
Thermal Resistance

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	
$R_{\theta JA-PCB}$	Junction-to-PCB Mounted	1.0	—	

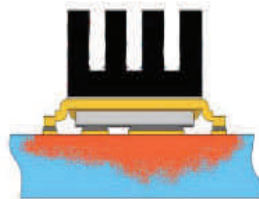

Fig 3. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient③
Notes:

- 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.

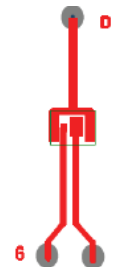
- ⑧ Mounted on minimum footprint full size board with metalized back and with small clip heat sink.
- ⑨ R_{θ} is measured at T_J of approximately 90°C .



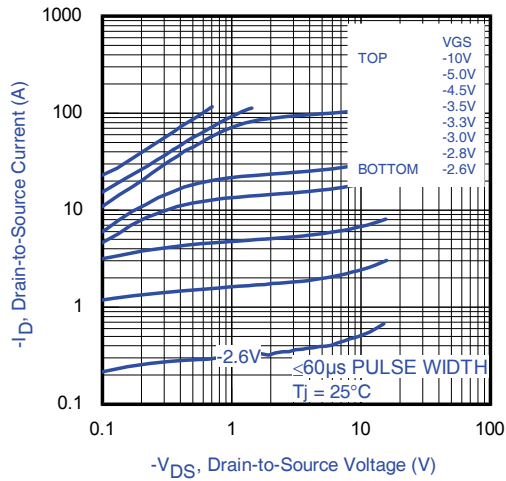
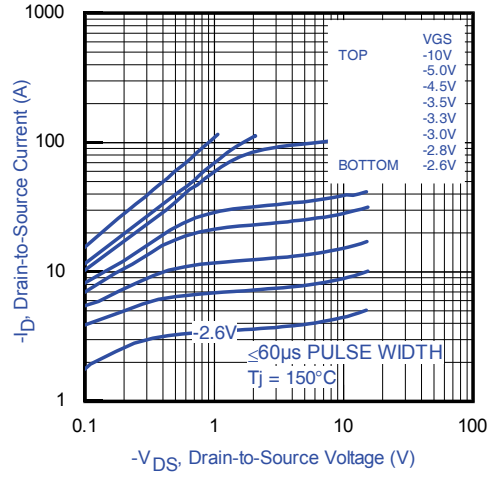
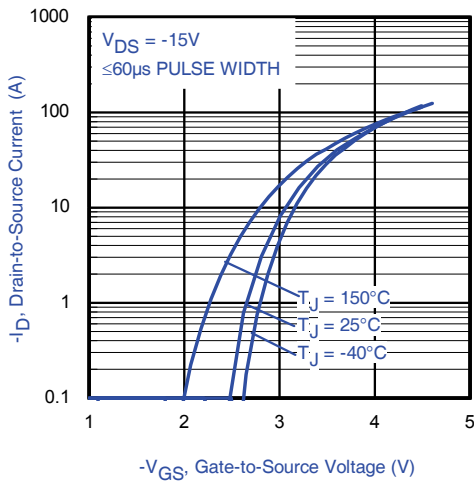
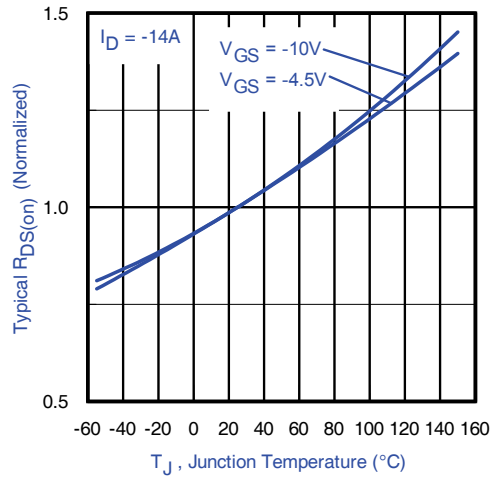
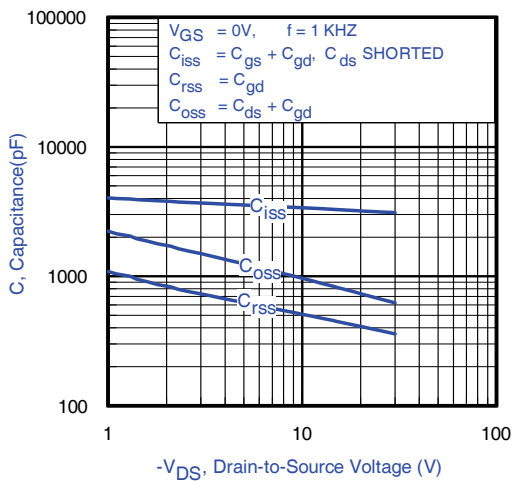
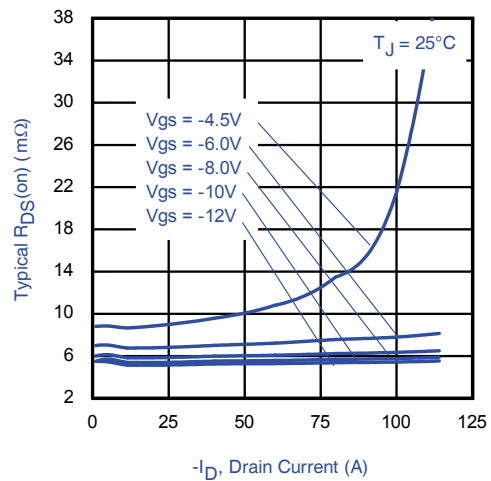
③ Surface mounted on 1 in. square Cu board (still air).

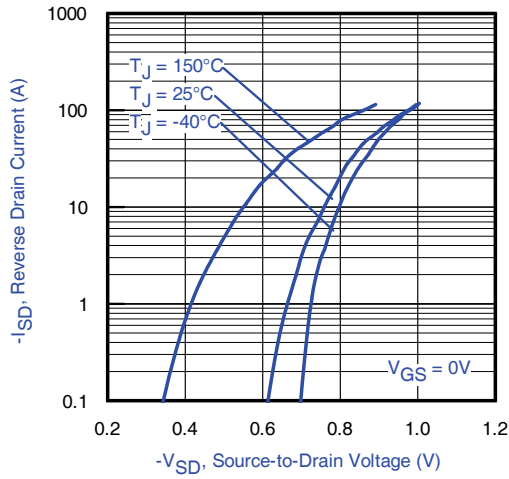
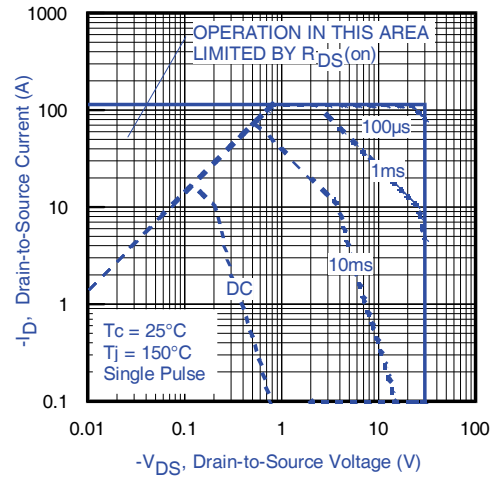
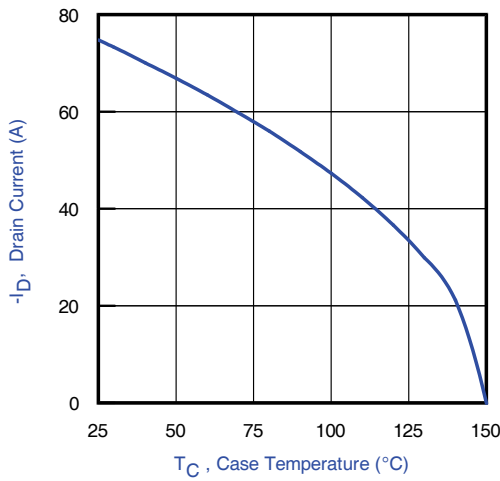
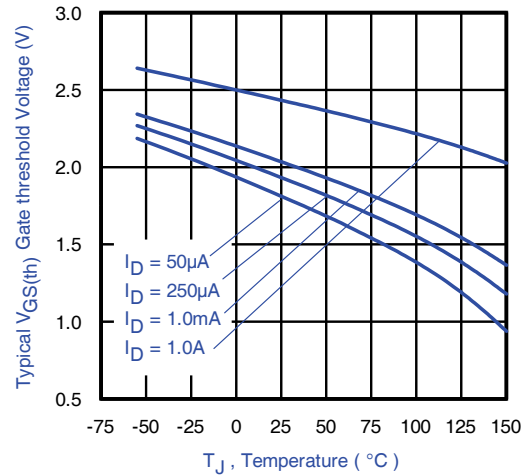
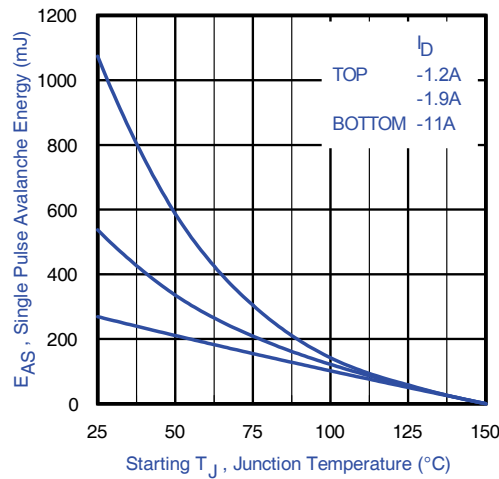


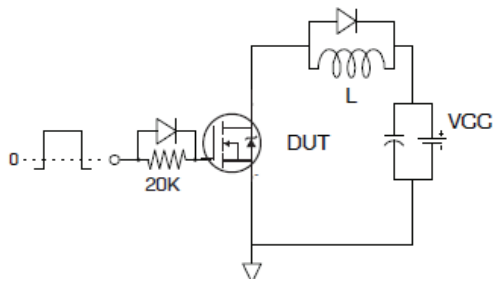
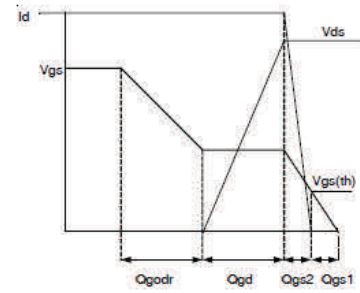
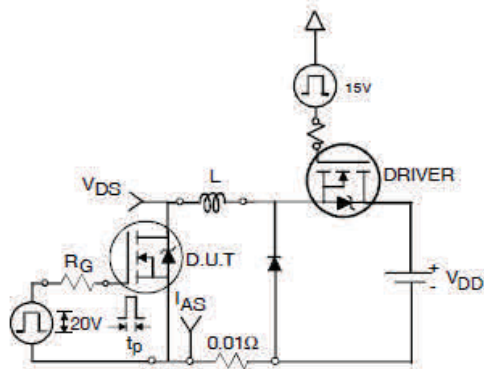
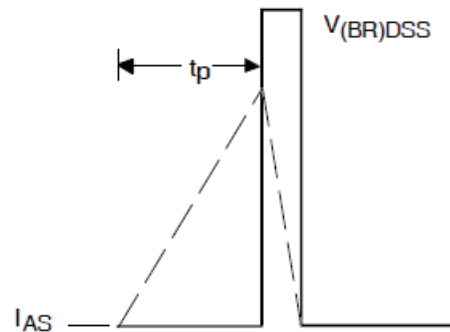
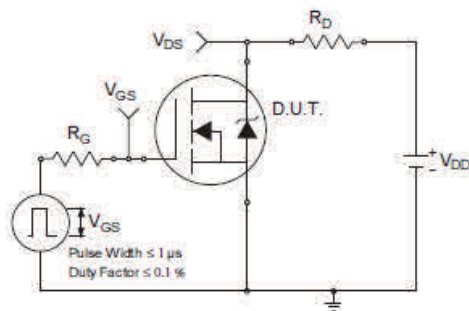
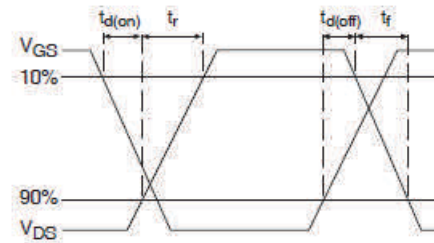
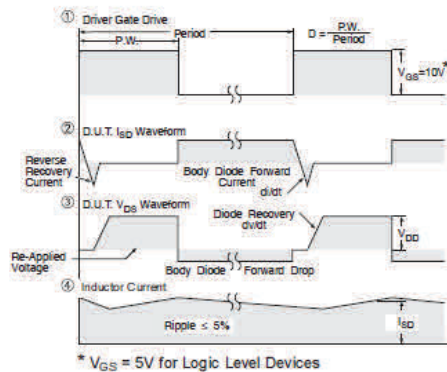
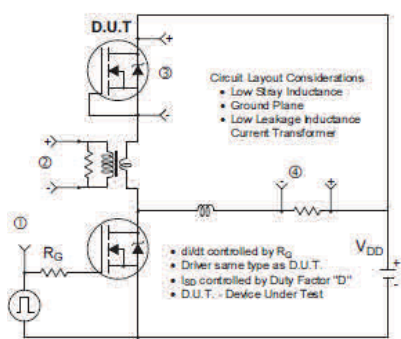
⑨ Mounted to a PCB with small clip heatsink (still air)



⑧ Mounted on minimum footprint full size board with metalized back and with small clip heatsink (still air)

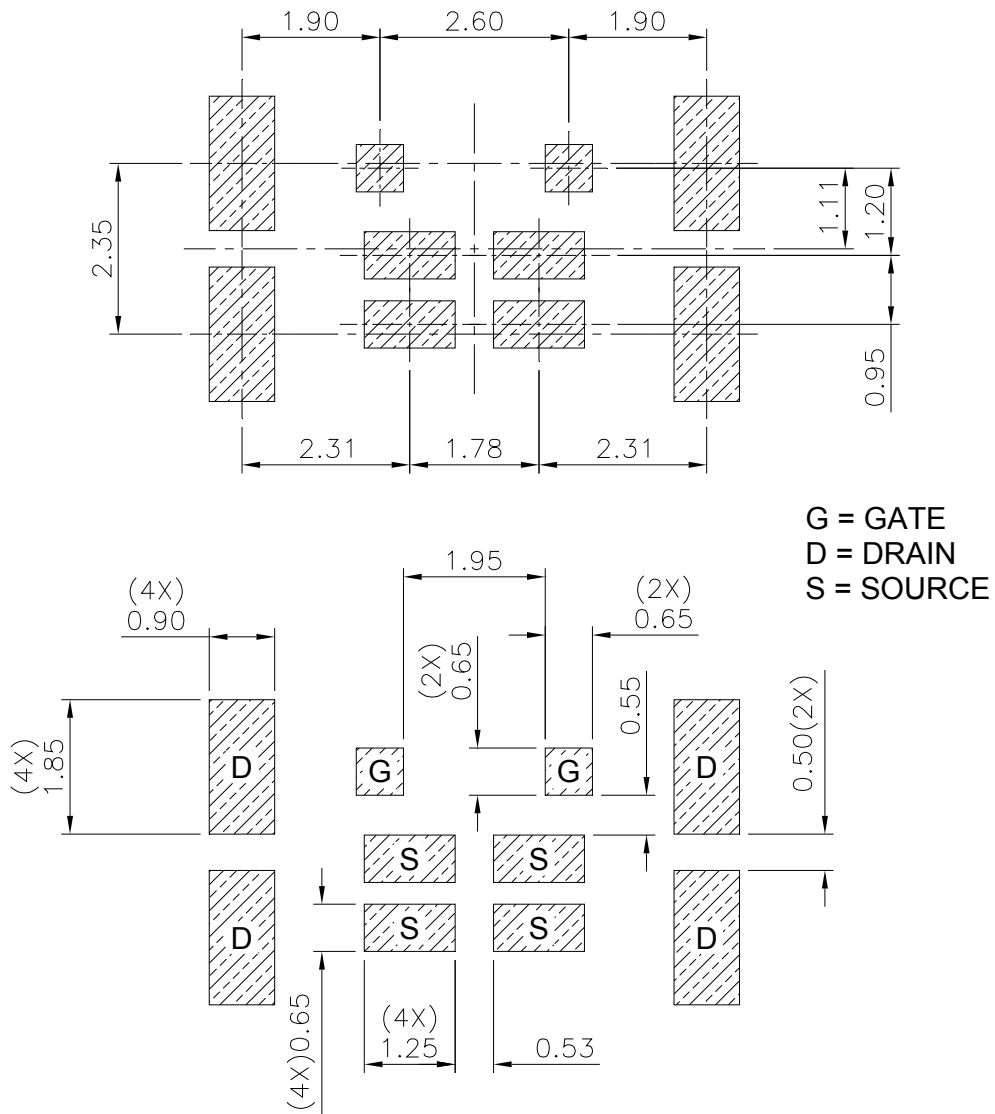

Fig 4. Typical Output Characteristics

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


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


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, MC Outline
(Medium Size Can, C-Designation).**

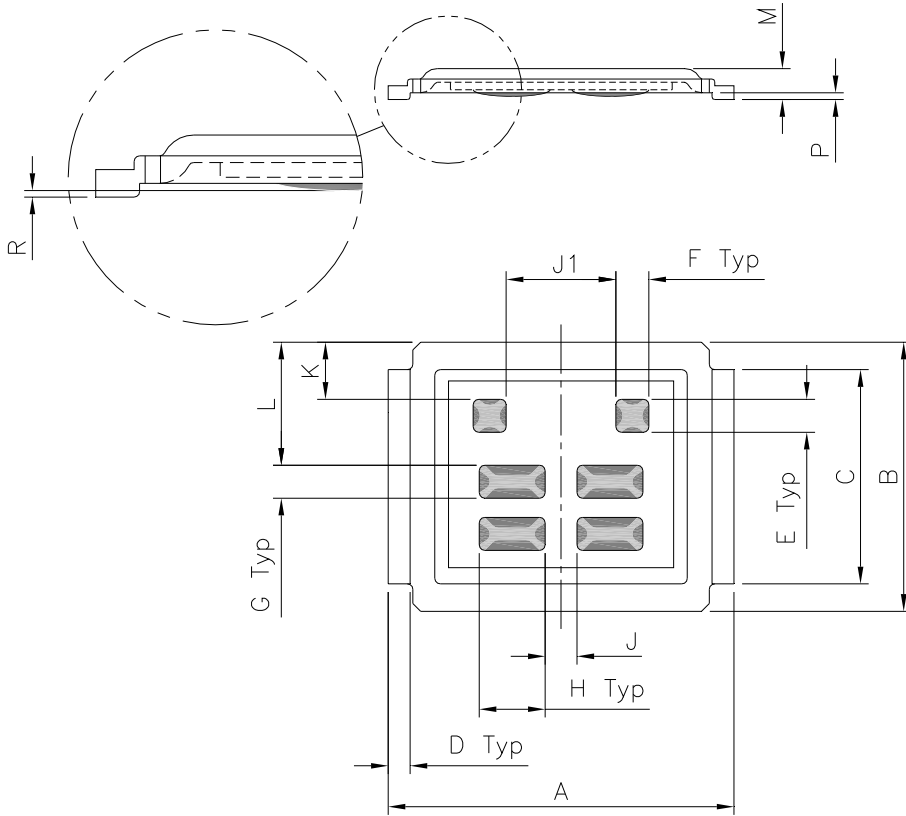
Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET. This includes all recommendations for stencil and substrate designs.



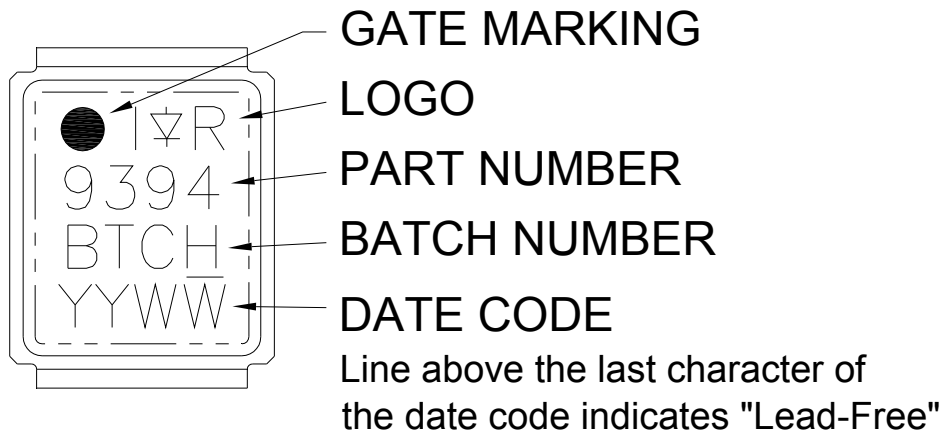
Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

**DirectFET™ Outline Dimension, MC Outline
(Medium Size Can, C-Designation).**

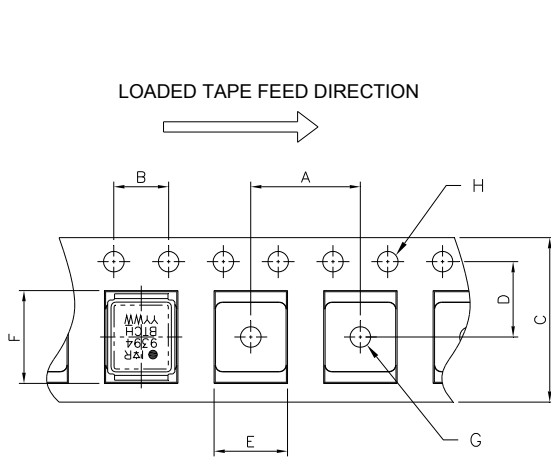
Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET. This includes all recommendations for stencil and substrate designs.



DIMENSIONS				
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	0.58	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

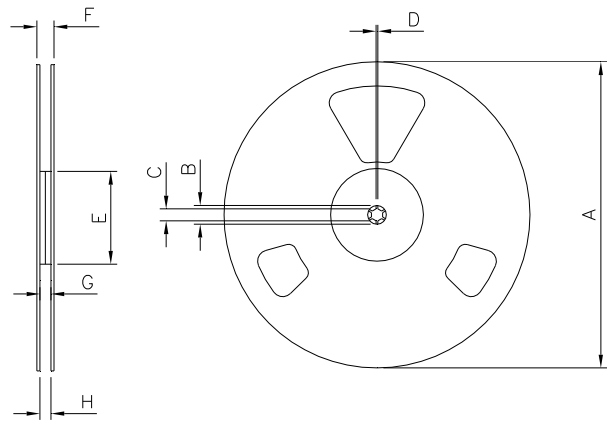
DirectFET™ Part Marking


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

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


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


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

REEL DIMENSIONS				
STANDARD OPTION (QTY 4800)				
CODE	METRIC		IMPERIAL	
	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.