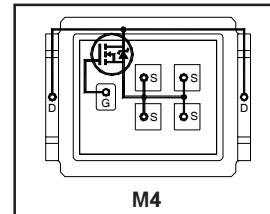


- Advanced Process Technology
- Optimized for Automotive Motor Drive, DC-DC and other Heavy Load Applications
- Exceptionally Small Footprint and Low Profile
- High Power Density
- Low Parasitic Parameters
- Dual Sided Cooling
- 175°C Operating Temperature
- Repetitive Avalanche Capability for Robustness and Reliability
- Lead Free, RoHS Compliant and Halogen Free
- Automotive Qualified \*

$V_{(BR)DSS}$	<b>60V</b>
$R_{DS(on)}$ <b>typ.</b>	<b>5.5mΩ</b>
	<b>7.0mΩ</b>
$I_D$ (Silicon Limited)	<b>68A</b>
$Q_g$	<b>35nC</b>



Applicable DirectFET® Outline and Substrate Outline ①

<b>SB</b>	<b>SC</b>			<b>M2</b>	<b>M4</b>		<b>L4</b>	<b>L6</b>	<b>L8</b>	
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### Description

The AUIRF7648M2 combines the latest Automotive HEXFET® Power MOSFET Silicon technology with the advanced DirectFET® packaging to achieve low gate charge as well as the lowest on-state resistance in a package that has the footprint of a 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 automotive power systems.

This HEXFET® Power MOSFET is designed for applications where efficiency and power density are of value. The advanced DirectFET® packaging platform coupled with the latest silicon technology allows the AUIRF7648M2 to offer substantial system level savings and performance improvement specifically in motor drive, high frequency DC-DC and other heavy load applications on ICE, HEV and EV platforms. This MOSFET utilizes the latest processing techniques to achieve low on-resistance and low  $Q_g$  per silicon area. Additional features of this MOSFET are 175°C operating junction temperature and high repetitive peak current capability. These features combine to make this MOSFET a highly efficient, robust and reliable device for high current automotive applications.

### Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; and functional operation of the device at these or any other condition beyond those indicated in the specifications is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions. Ambient temperature ( $T_A$ ) is 25°C, unless otherwise specified.

	Parameter	Max.	Units
$V_{DS}$	Drain-to-Source Voltage	60	V
$V_{GS}$	Gate-to-Source Voltage	± 20	
$I_D @ T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$ (Silicon Limited)④	68	A
$I_D @ T_C = 100^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$ (Silicon Limited)④	48	
$I_D @ T_A = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$ (Silicon Limited)③	14	
$I_D @ T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$ (Package Limited)	179	
$I_{DM}$	Pulsed Drain Current ⑤	272	W
$P_D @ T_C = 25^\circ\text{C}$	Power Dissipation ④	63	
$P_D @ T_A = 25^\circ\text{C}$	Power Dissipation ③	2.5	mJ
$E_{AS}$	Single Pulse Avalanche Energy (Thermally Limited) ⑥	70	
$E_{AS}(\text{tested})$	Single Pulse Avalanche Energy Tested Value ⑥	291	A
$I_{AR}$	Avalanche Current ⑤	See Fig. 18a,18b,16,17	
$E_{AR}$	Repetitive Avalanche Energy ⑤		mJ
$T_P$	Peak Soldering Temperature	270	°C
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to + 175	

### Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient ③	—	60	°C/W
$R_{\theta JA}$	Junction-to-Ambient ③	12.5	—	
$R_{\theta JA}$	Junction-to-Ambient ③	20	—	
$R_{\theta J-Can}$	Junction-to-Can ④⑩	—	2.4	
$R_{\theta J-PCB}$	Junction-to-PCB Mounted	1.0	—	
	Linear Derating Factor ④	0.42		W/°C

HEXFET® is a registered trademark of International Rectifier.


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

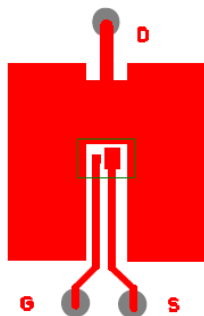
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	60	—	—	V	$V_{GS} = 0V, I_D = 250\mu A$
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.07	—	V/ $^\circ\text{C}$	Reference to $25^\circ\text{C}, I_D = 1\text{mA}$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	5.5	7.0	m $\Omega$	$V_{GS} = 10V, I_D = 41A$ ②
$V_{GS(th)}$	Gate Threshold Voltage	3.0	4.0	4.9	V	$V_{DS} = V_{GS}, I_D = 150\mu A$
$\Delta V_{GS(th)}/\Delta T_J$	Gate Threshold Voltage Coefficient	—	-12	—	mV/ $^\circ\text{C}$	
$g_{fs}$	Forward Transconductance	44	—	—	S	$V_{DS} = 25V, I_D = 41A$
$R_G$	Gate Resistance	—	1.4	—	$\Omega$	
$I_{DSS}$	Drain-to-Source Leakage Current	—	—	5	$\mu A$	$V_{DS} = 60V, V_{GS} = 0V$
		—	—	250		$V_{DS} = 60V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	—	—	100	nA	$V_{GS} = 20V$
	Gate-to-Source Reverse Leakage	—	—	-100		$V_{GS} = -20V$

## Dynamic Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise stated)

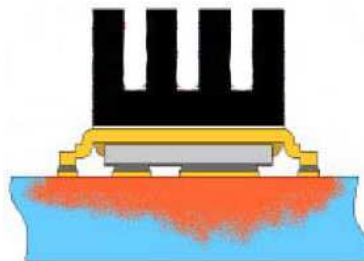
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge	—	35	53	nC	$V_{DS} = 30V, V_{GS} = 10V$ $I_D = 41A$ See Fig. 11
$Q_{gs1}$	Pre-V <sub>th</sub> Gate-to-Source Charge	—	7.7	—		
$Q_{gs2}$	Post-V <sub>th</sub> Gate-to-Source Charge	—	3.4	—		
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	—	14	—		
$Q_{godr}$	Gate Charge Overdrive	—	9.9	—		
$Q_{sw}$	Switch Charge ( $Q_{gs2} + Q_{gd}$ )	—	17.4	—		
$Q_{oss}$	Output Charge	—	23	—	nC	$V_{DS} = 16V, V_{GS} = 0V$
$t_{d(on)}$	Turn-On Delay Time	—	12	—	ns	$V_{DD} = 30V, V_{GS} = 10V$ ② $I_D = 41A$ $R_G = 6.8\Omega$
$t_r$	Rise Time	—	23	—		
$t_{d(off)}$	Turn-Off Delay Time	—	19	—		
$t_f$	Fall Time	—	14	—		
$C_{iss}$	Input Capacitance	—	2170	—	pF	$V_{GS} = 0V$ $V_{DS} = 25V$ $f = 1.0\text{MHz}$ $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0\text{MHz}$ $V_{GS} = 0V, V_{DS} = 48V, f = 1.0\text{MHz}$ $V_{GS} = 0V, V_{DS} = 0V \text{ to } 48V$
$C_{oss}$	Output Capacitance	—	633	—		
$C_{riss}$	Reverse Transfer Capacitance	—	162	—		
$C_{oss}$	Output Capacitance	—	2661	—		
$C_{oss}$	Output Capacitance	—	465	—		
$C_{oss \text{ eff.}}$	Effective Output Capacitance	—	726	—		

## Diode Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise stated)

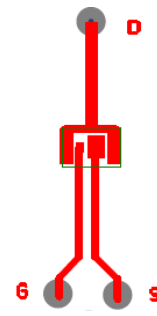
	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_S$	Continuous Source Current (Body Diode)	—	—	68	A	MOSFET symbol showing the integral reverse p-n junction diode. 
$I_{SM}$	Pulsed Source Current (Body Diode) ③	—	—	272		
$V_{SD}$	Diode Forward Voltage	—	—	1.3	V	$I_S = 41A, V_{GS} = 0V$ ②
$t_{rr}$	Reverse Recovery Time	—	36	54	ns	$I_F = 41A, V_{DD} = 25V$
$Q_{rr}$	Reverse Recovery Charge	—	46	69	nC	$di/dt = 100A/\mu s$ ②



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



② Mounted to a PCB with small clip heatsink (still air)



② Mounted on minimum footprint full size board with metalized back and with small clip heatsink (still air)

Notes ① through ⑩ are on page 10

## Qualification Information<sup>†</sup>

<b>Qualification Level</b>		Automotive (per AEC-Q101) <sup>††</sup>	
		Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
<b>Moisture Sensitivity Level</b>		MEDIUM-CAN	MSL1, 260°C
<b>ESD</b>	Machine Model	Class M4 ( +/- 400V) AEC-Q101-002	
	Human Body Model	Class H2( +/- 4000V) AEC-Q101-001	
	Charged Device Model	N/A AEC-Q101-005	
<b>RoHS Compliant</b>		Yes	

† Qualification standards can be found at International Rectifier's web site: <http://www.irf.com>

†† Exceptions to AEC-Q101 requirements are noted in the qualification report.

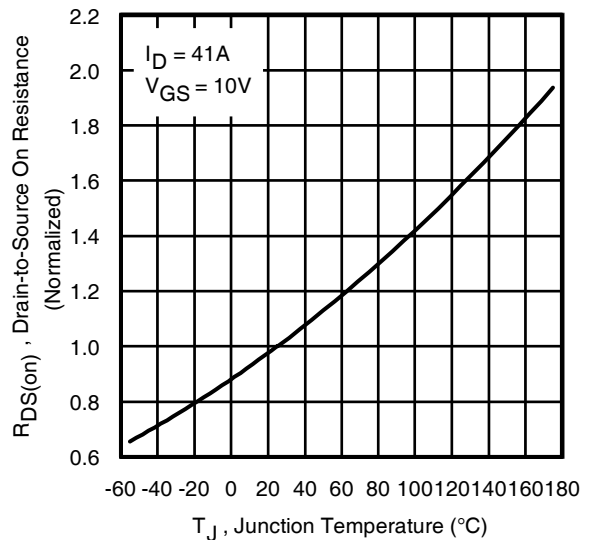
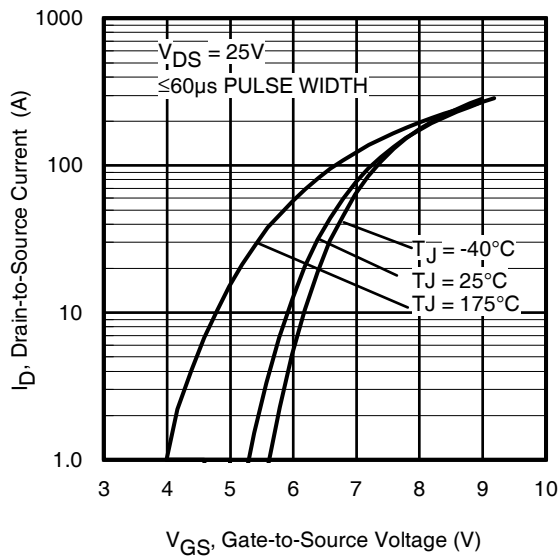
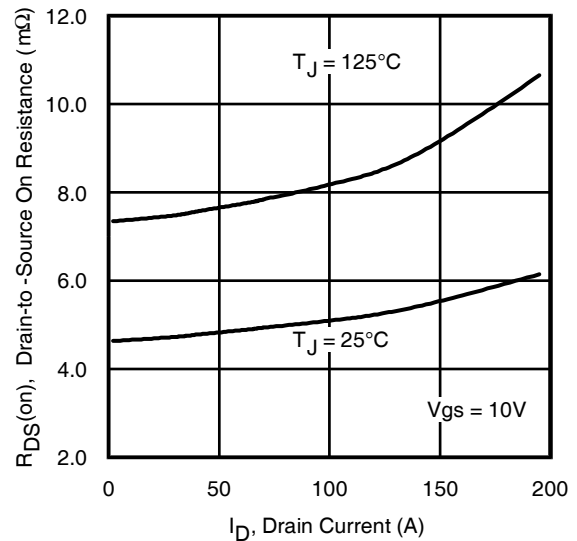
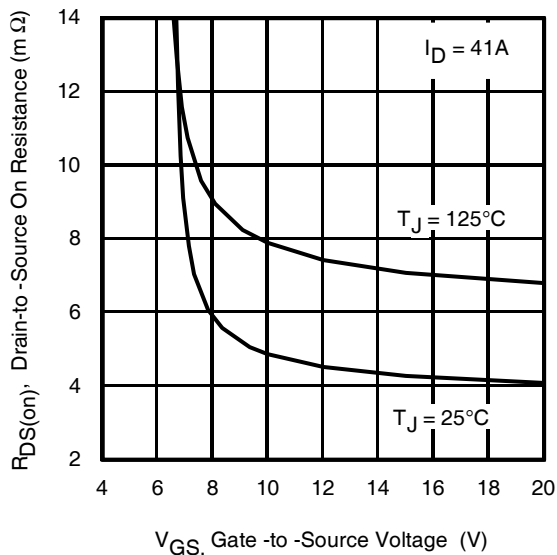
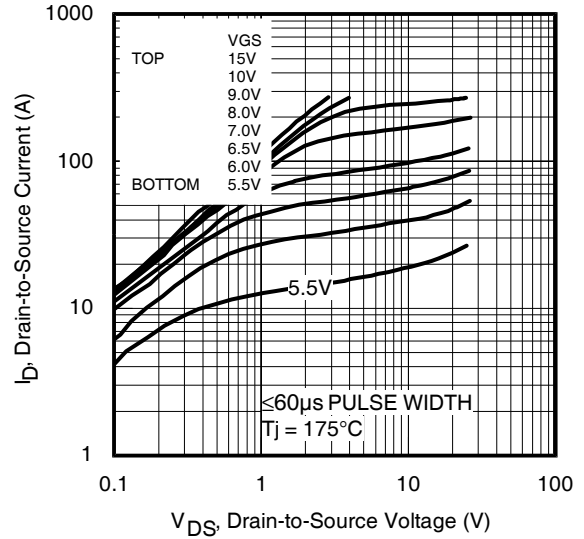
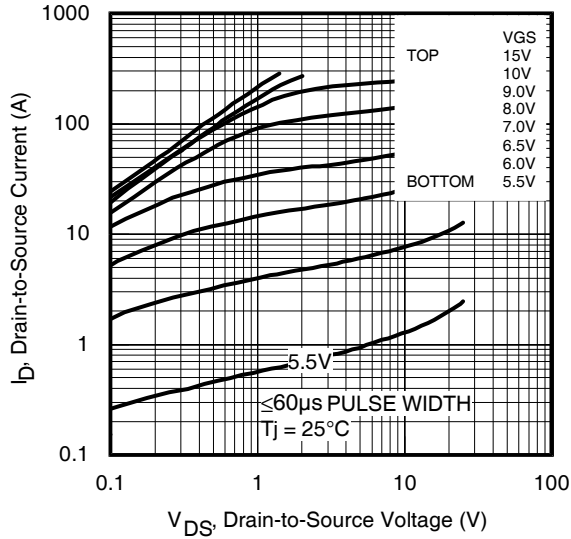
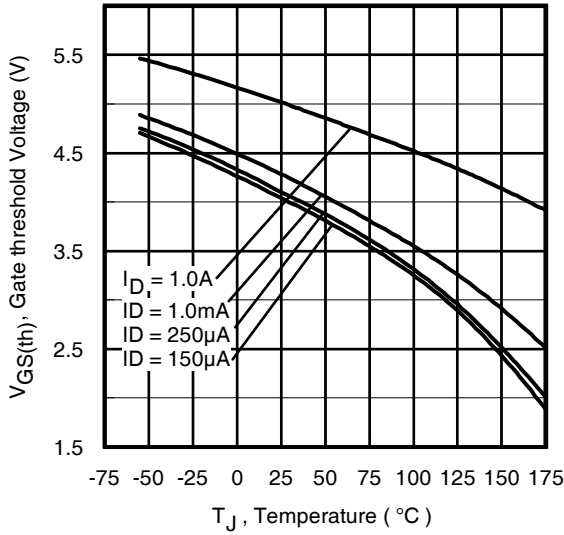
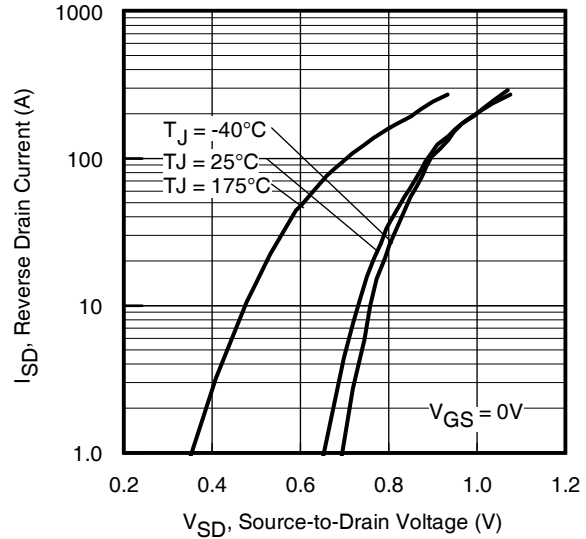


Fig 5. Typical Transfer Characteristics

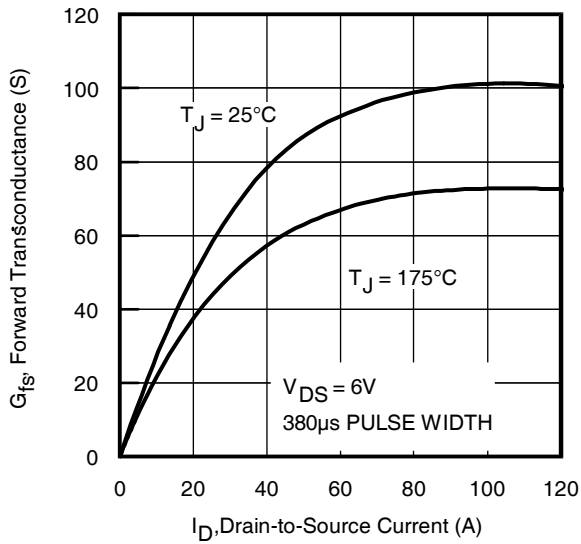
Fig 6. Normalized On-Resistance vs. Temperature



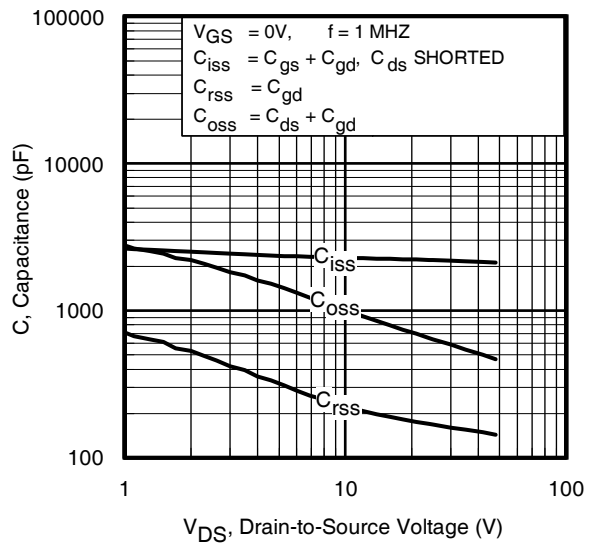
**Fig 7.** Typical Threshold Voltage vs. Junction Temperature



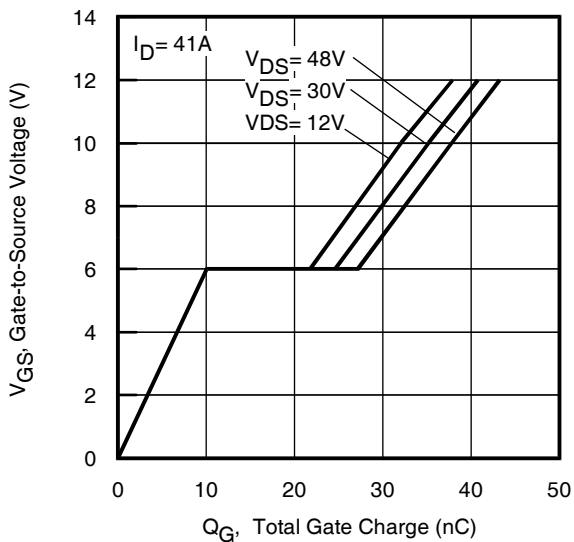
**Fig 8.** Typical Source-Drain Diode Forward Voltage



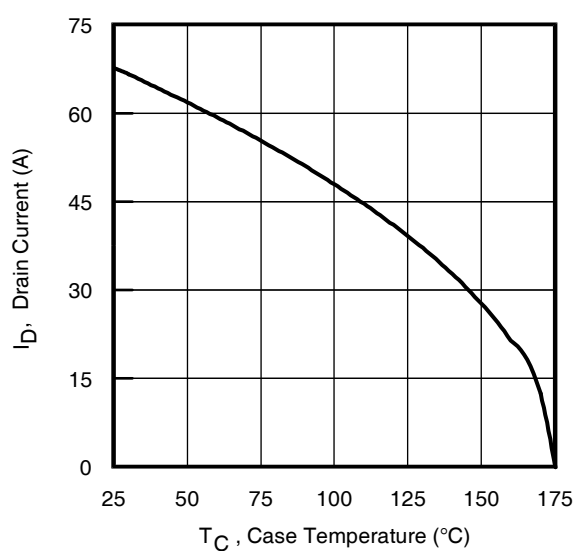
**Fig 9.** Typical Forward Transconductance Vs. Drain Current



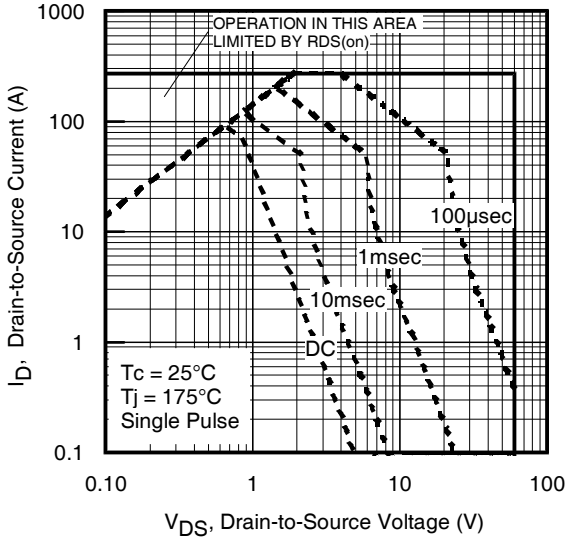
**Fig 10.** Typical Capacitance vs. Drain-to-Source Voltage



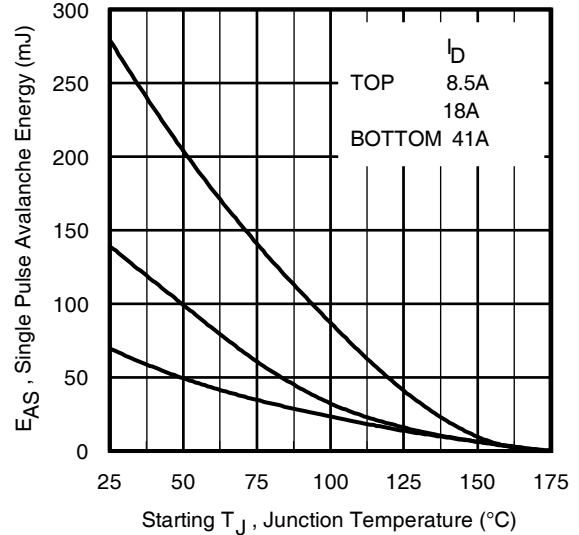
**Fig.11** Typical Gate Charge vs. Gate-to-Source Voltage  
www.irf.com



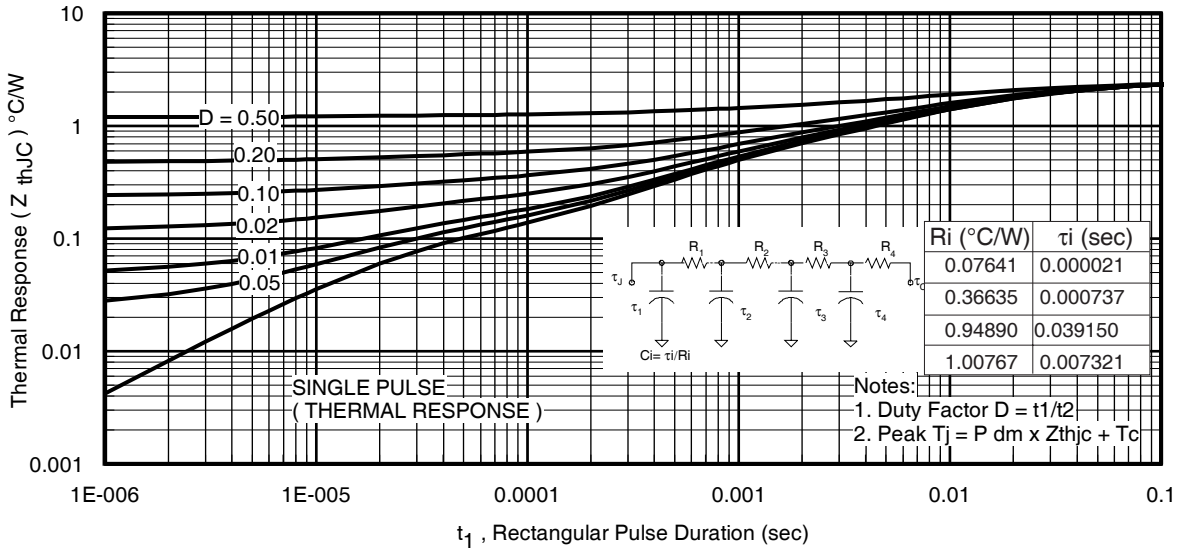
**Fig 12.** Maximum Drain Current vs. Case Temperature



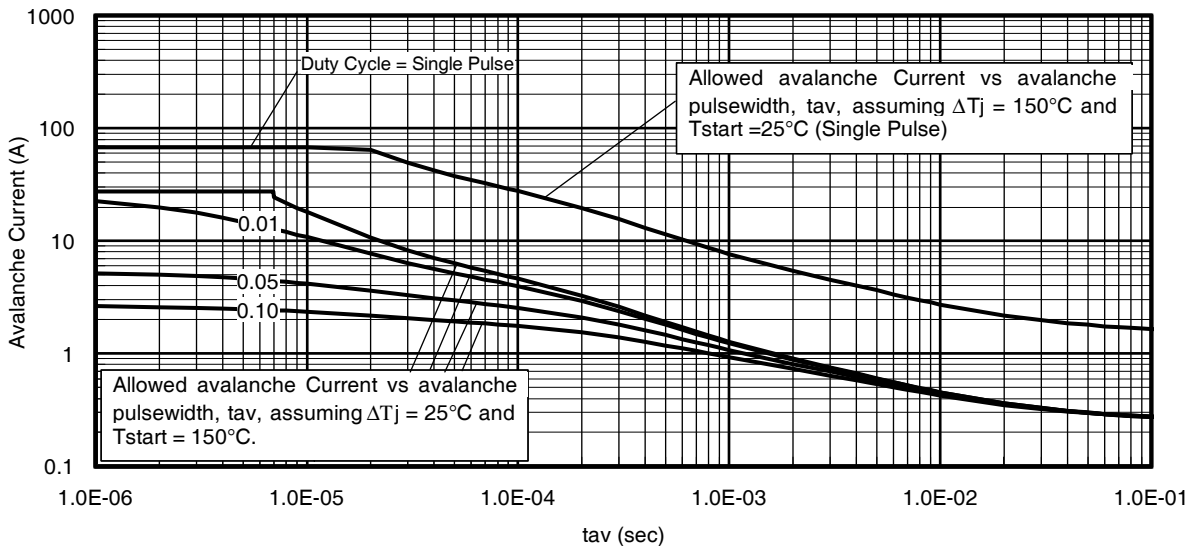
**Fig 13.** Maximum Safe Operating Area



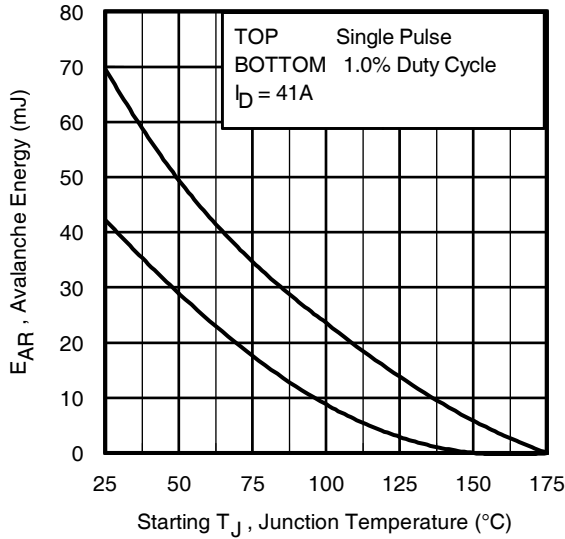
**Fig 14.** Maximum Avalanche Energy vs. Temperature



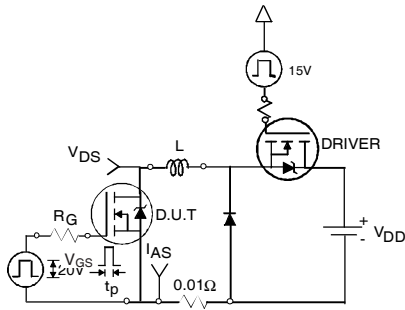
**Fig 15.** Maximum Effective Transient Thermal Impedance, Junction-to-Case



**Fig 16.** Typical Avalanche Current Vs. Pulsewidth



**Fig 17.** Maximum Avalanche Energy Vs. Temperature

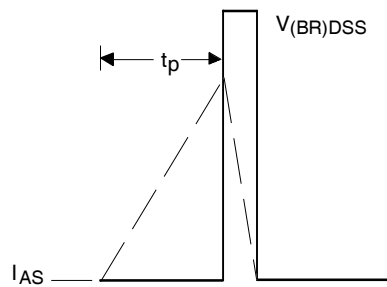


**Fig 18a.** Unclamped Inductive Test Circuit

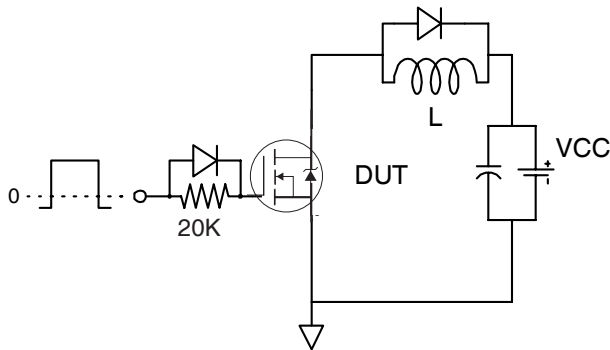
$$P_{D(ave)} = 1/2 (1.3 \cdot BV \cdot I_{av}) \cdot \Delta T / Z_{thJC}$$

$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

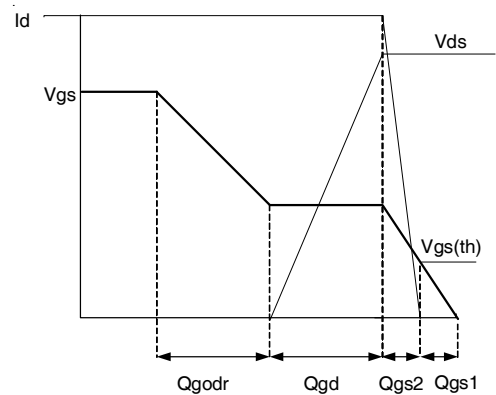
$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$



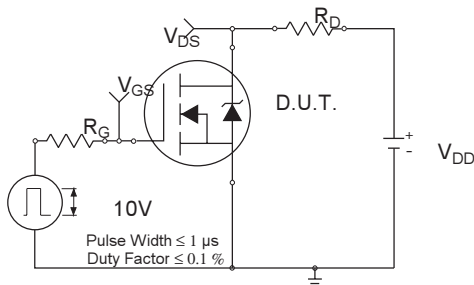
**Fig 18b.** Unclamped Inductive Waveforms



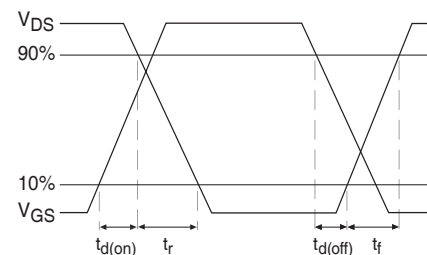
**Fig 19a.** Gate Charge Test Circuit



**Fig 19b.** Gate Charge Waveform



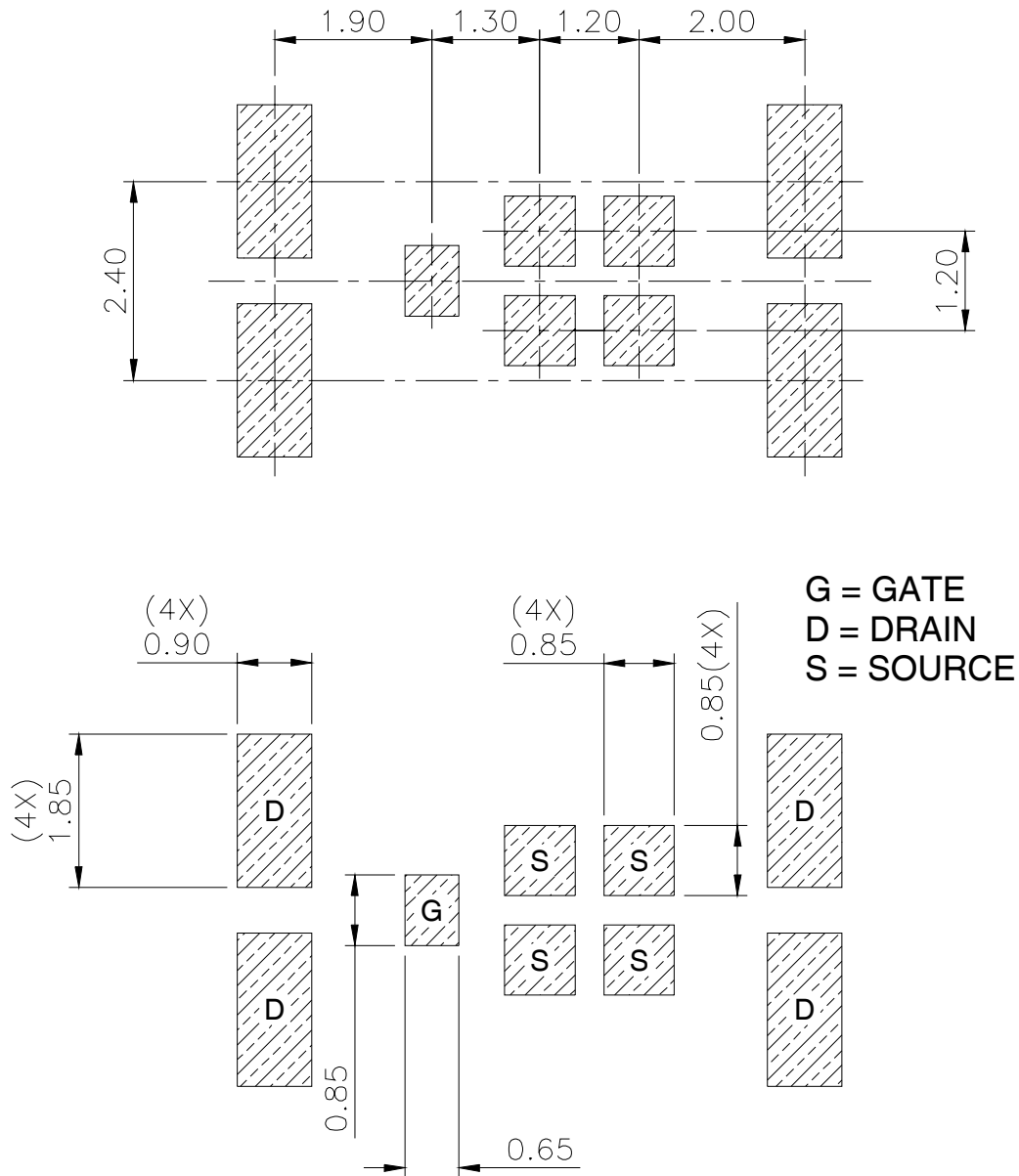
**Fig 20a.** Switching Time Test Circuit



**Fig 20b.** Switching Time Waveforms

## DirectFET® Board Footprint, M4 (Medium Size Can).

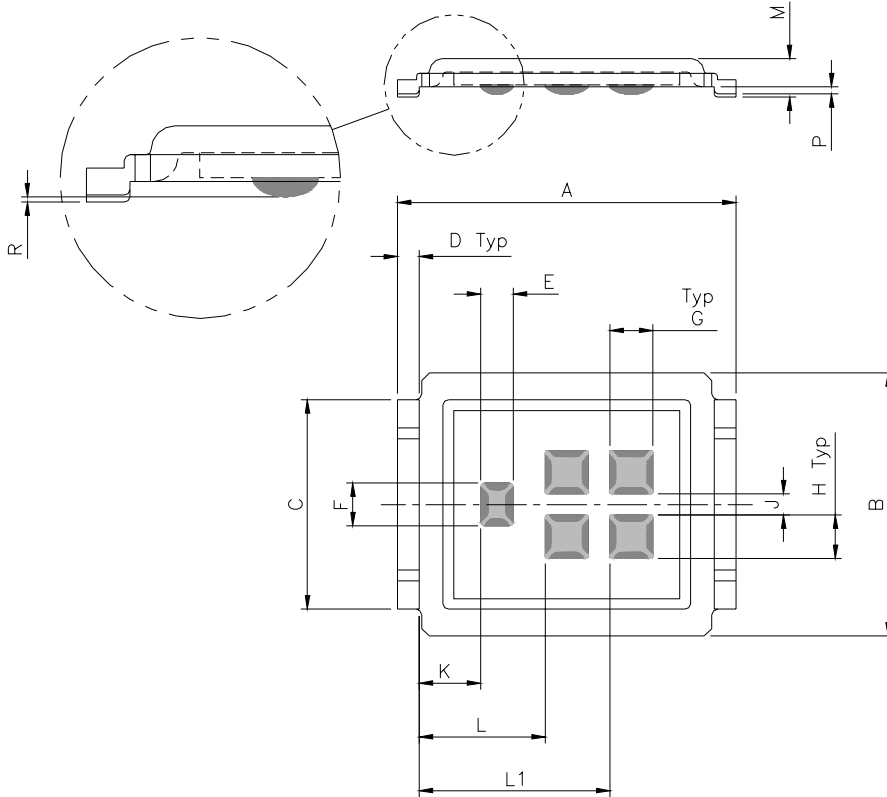
Please see AN-1035 for DirectFET® assembly details and stencil and substrate design recommendations





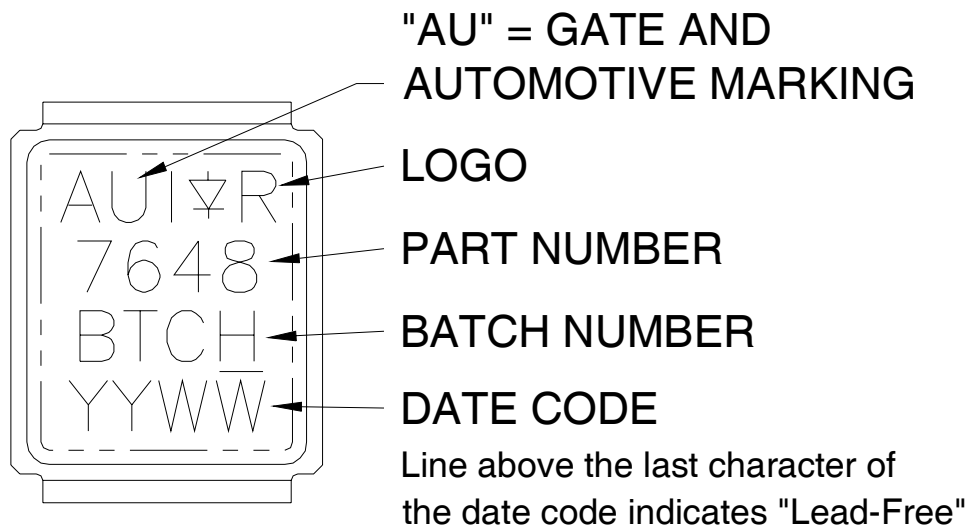
## DirectFET® Outline Dimension, M4 Outline (Medium Size Can).

Please see AN-1035 for DirectFET® assembly details and stencil and substrate design recommendations



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	0.58	0.62	0.023	0.024
F	0.78	0.82	0.031	0.032
G	0.78	0.82	0.031	0.032
H	0.78	0.82	0.031	0.032
J	0.38	0.42	0.015	0.017
K	1.10	1.20	0.043	0.047
L	2.30	2.40	0.090	0.094
L1	3.50	3.60	0.138	0.142
M	0.68	0.74	0.027	0.029
P	0.09	0.17	0.003	0.007
R	0.02	0.08	0.001	0.003

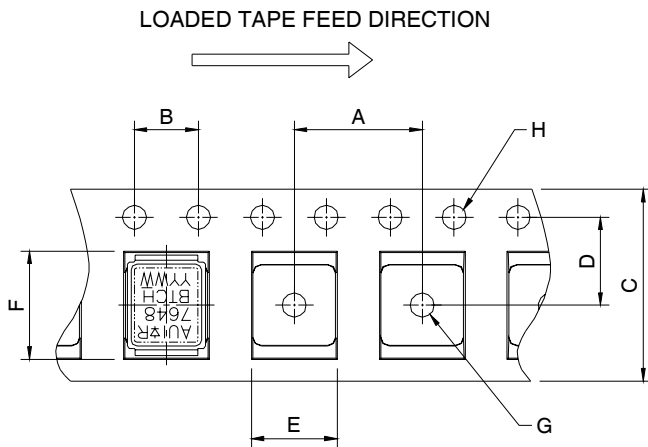
## DirectFET® Part Marking



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

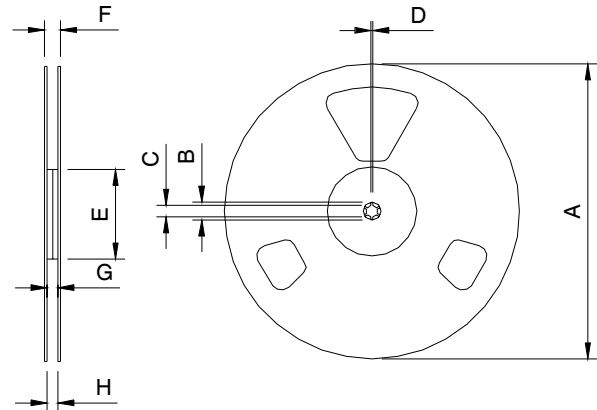
[www.irf.com](http://www.irf.com)

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



NOTE: CONTROLLING DIMENSIONS IN MM

CODE	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



NOTE: Controlling dimensions in mm  
Std reel quantity is 4800 parts. (ordered as AUIRF7648M2TR). For 1000 parts on 7" reel, order AUIRF7648M2TR1

CODE	REEL DIMENSIONS							
	STANDARD OPTION (QTY 4800)				TR1 OPTION (QTY 1000)			
	METRIC		IMPERIAL		METRIC		IMPERIAL	
	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

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

- ⑥ Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.084\text{mH}$ ,  $R_G = 50\Omega$ ,  $I_{AS} = 41\text{A}$ ,  $V_{GS} = 20\text{V}$ .
- ⑦ Pulse width  $\leq 400\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- ⑧ Used double sided cooling, mounting pad with large heatsink.
- ⑨ Mounted on minimum footprint full size board with metalized back and with small clip heatsink.
- ⑩  $R_\theta$  is measured at  $T_J$  of approximately  $90^\circ\text{C}$ .

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For technical support, please contact IR's Technical Assistance Center

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