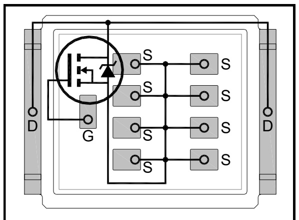
Automotive DirectFET® Power MOSFET ②

- 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 Allowed up to Tjmax
- Lead Free, RoHS Compliant and Halogen Free
- Automotive Qualified *

$V_{(BR)DSS}$	**40V**
$R_{DS(on)}$ typ.	**0.35mΩ**
max.	**0.6mΩ**
I_D (Silicon Limited)	**545A**
Q_g	**375nC**



L8

DirectFET2 L-can

Applicable DirectFET® Outline and Substrate Outline ①

SB	SC			M2	M4		L4	L6	**L8**	

Description

The AUIRF8739L2 combines the latest Automotive HEXFET® Power MOSFET Silicon technology with the advanced DirectFET® packaging technology to achieve exceptional performance in a package that has the footprint of an SO-8 or 5X6mm PQFN and only 0.7mm 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 AUIRF8739L2 to offer substantial system level savings and performance improvement specifically in motor drive, DC-DC and other heavy load applications on ICE, HEV and EV platforms. This MOSFET utilizes the latest processing techniques to achieve ultra low on-resistance 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.

Base Part Number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
AUIRF8739L2	DirectFET®	Tape and Reel	4000	AUIRF8739L2TR

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 (TA) is 25°C, unless otherwise specified.

	Parameter	Max.	Units
V_{DS}	Drain-to-Source Voltage	40	V
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V ④	545	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V ④	385	
I_D @ T_A = 25°C	Continuous Drain Current, V_{GS} @ 10V ③	57	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Package limit)④	375	
I_{DM}	Pulsed Drain Current ⑤	1150	
P_D @T_C = 25°C	Power Dissipation ④	340	W
P_D @T_A = 25°C	Power Dissipation ③	3.8	
E_{AS}	Single Pulse Avalanche Energy (Thermally Limited) ⑥	312	mJ
E_{AS} (Tested)	Single Pulse Avalanche Energy	1500**	
I_{AR}	Avalanche Current ⑤	See Fig. 14, 15, 22a, 22b	A
E_{AR}	Repetitive Avalanche Energy ⑤		
T_P	Peak Soldering Temperature	270	mJ
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C

*Qualification standards can be found at http://www.irf.com/

Thermal Resistance

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient ③	——	40	°C/W
$R_{\theta JA}$	Junction-to-Ambient ⑧	12.5	——	
$R_{\theta JA}$	Junction-to-Ambient ⑨	20	——	
$R_{\theta J\text{-}Can}$	Junction-to-Can ④⑩	——	0.44	
$R_{\theta J\text{-}PCB}$	Junction-to-PCB Mounted	——	0.5	
	Linear Derating Factor ④	2.3		W/°C

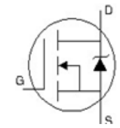
Static Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

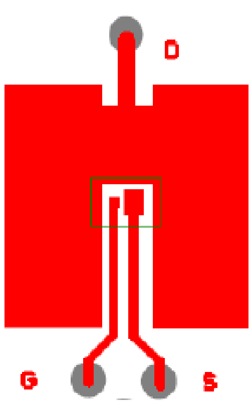
Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	40	——	——	V	V_{GS} = 0V, I_D = 250μA
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	——	0.03	——	V/°C	Reference to 25°C, I_D = 5.0mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	——	0.35	0.60	mΩ	V_{GS} = 10V, I_D = 195A ⑦
$V_{GS(th)}$	Gate Threshold Voltage	2.2	——	3.9	V	V_{DS} = V_{GS}, I_D = 250μA
$\Delta V_{GS(th)}/\Delta T_J$	Gate Threshold Voltage Coefficient	——	-12	——	mV/°C	
gfs	Forward Transconductance	250	——	——	S	V_{DS} = 10V, I_D = 195A
R_G	Internal Gate Resistance	——	0.81	——	Ω	
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

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge	——	375	562	nC	V_{DS} = 20V
Q_{gs1}	Gate-to-Source Charge	——	60	——		V_{GS} = 10V
Q_{gs2}	Gate-to-Source Charge	——	40	——		I_D = 195A
Q_{gd}	Gate-to-Drain ("Miller") Charge	——	120	——		
Q_{godr}	Gate Charge Overdrive	——	155	——		
Q_{sw}	Switch Charge (Q_{gs2} + Q_{gd})	——	160	——		
Q_{oss}	Output Charge	——	151	——	nC	V_{DS} = 32V, V_{GS} = 0V
$t_{d(on)}$	Turn-On Delay Time	——	34	——	ns	V_{DD} = 20V, V_{GS} = 10V ⑦
t_r	Rise Time	——	117	——		I_D = 195A
$t_{d(off)}$	Turn-Off Delay Time	——	120	——		R_G = 1.8Ω
t_f	Fall Time	——	95	——		
C_{iss}	Input Capacitance	——	17890	——	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	——	2640	——		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	——	1830	——		f = 500 kHz
C_{oss} eff.	Effective Output Capacitance	——	3785	——		V_{GS} = 0V, V_{DS} = 0V to 32V

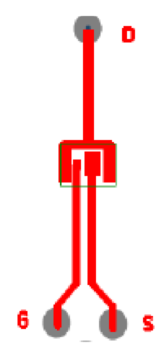
Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	——	——	545	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ⑤	——	——	1150	A	
V_{SD}	Diode Forward Voltage	——	——	1.2	V	T_J = 25°C, I_S = 195A, V_{GS} = 0V ⑦
t_{rr}	Reverse Recovery Time	——	47	——	ns	I_F = 195A, V_{DD} = 20V
Q_{rr}	Reverse Recovery Charge	——	66	——	nC	dv/dt = 100A/μs ⑦



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).

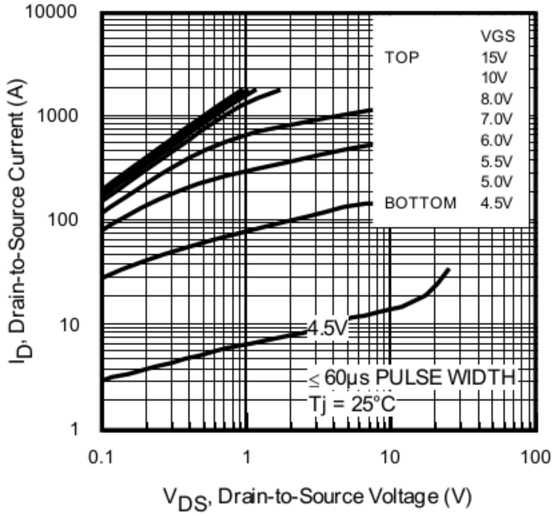


Fig. 1 Typical Output Characteristics

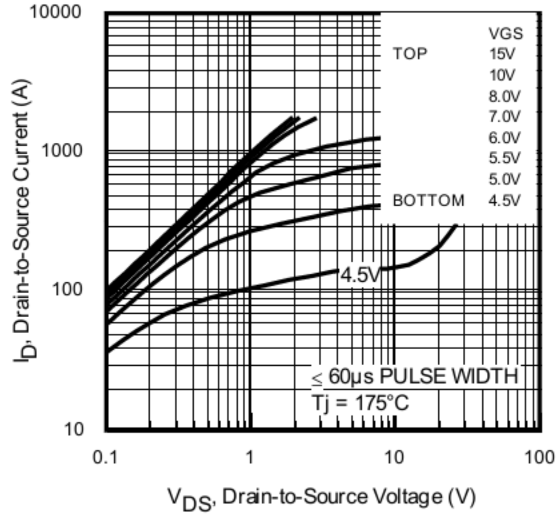


Fig. 2 Typical Output Characteristics

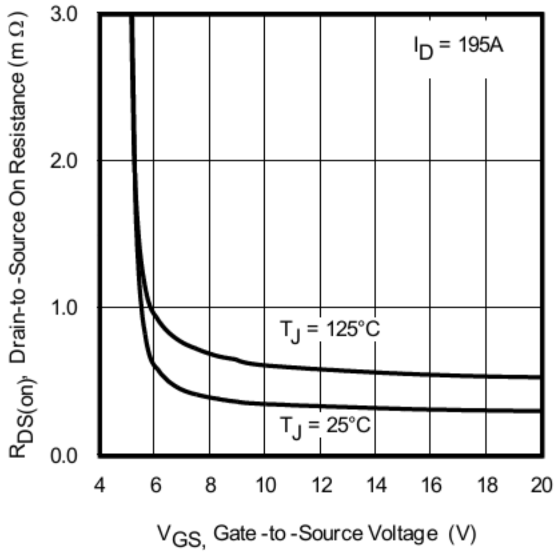


Fig. 3 Typical On-Resistance vs. Gate Volt-

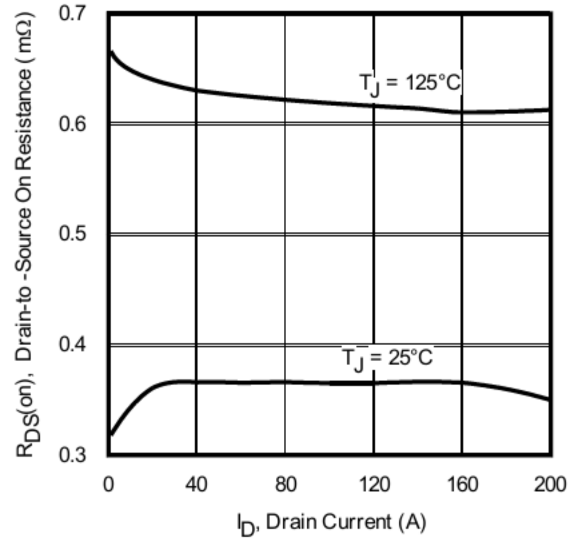


Fig. 4 Typical On-Resistance vs. Drain Current

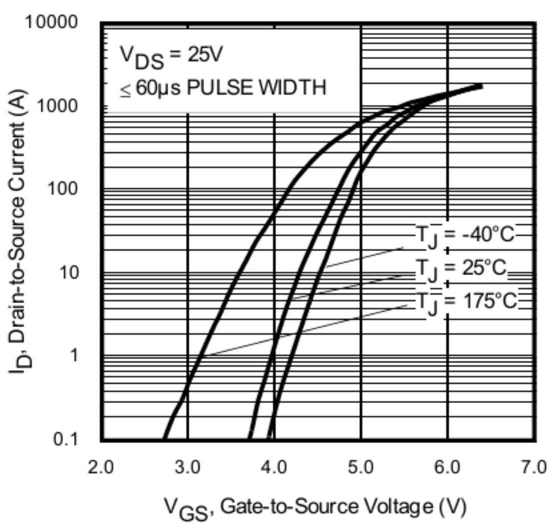


Fig 5. Transfer Characteristics

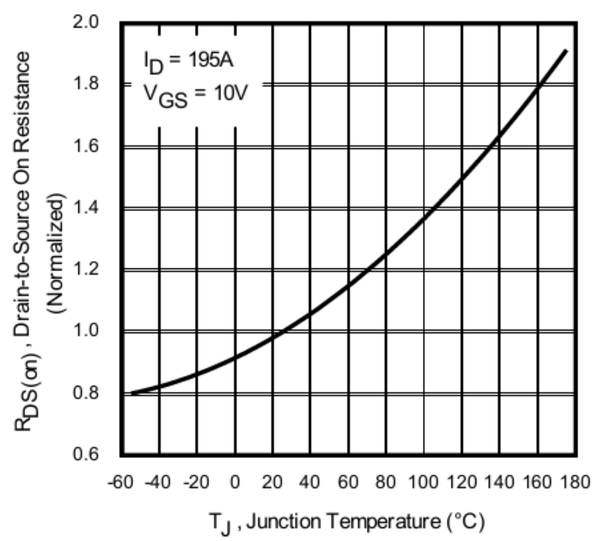


Fig 6. Normalized On-Resistance vs. Temperature

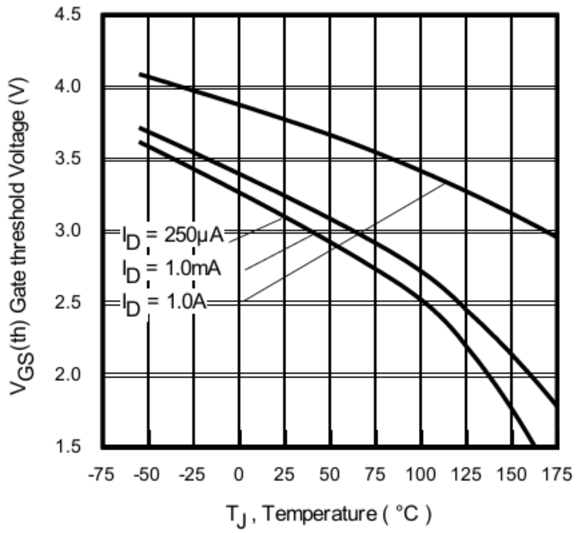


Fig. 7 Typical Threshold Voltage vs. Junction Temperature

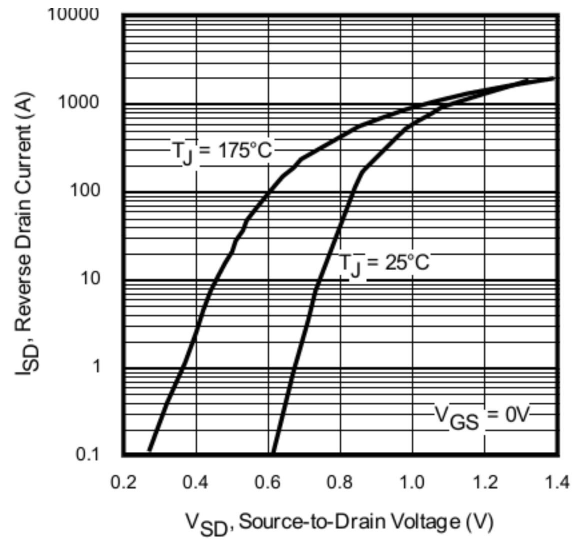


Fig 8. Typical Source-Drain Diode Forward Voltage

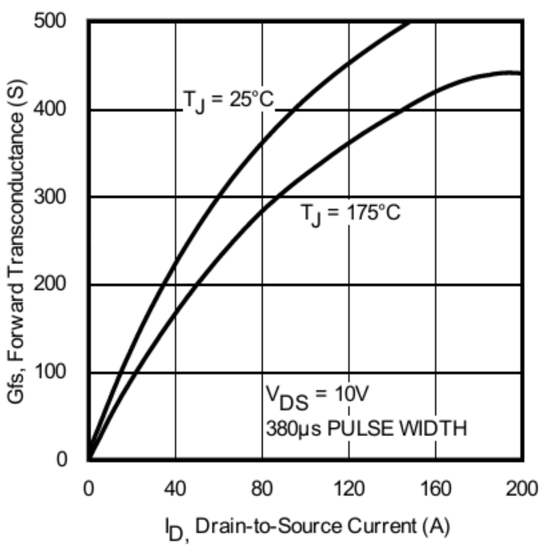


Fig 9. Typical Forward Transconductance vs. Drain Cur-

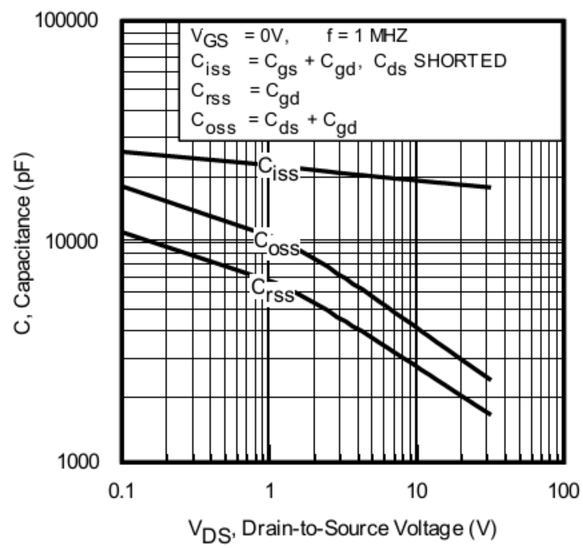


Fig 10. Typical Capacitance vs. Drain-to-Source Volt-

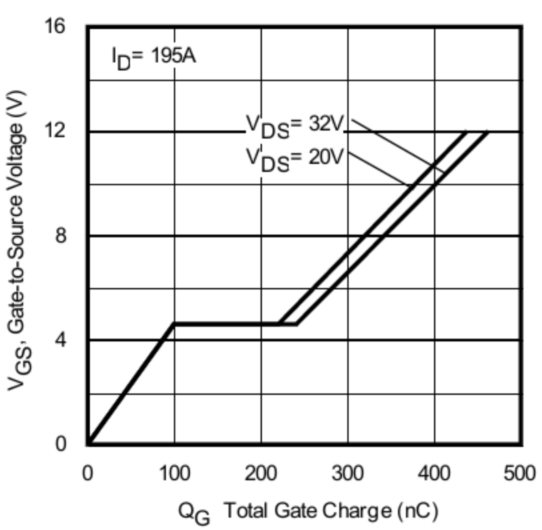


Fig 11. Typical Gate Charge vs. Gate-to-Source Voltage

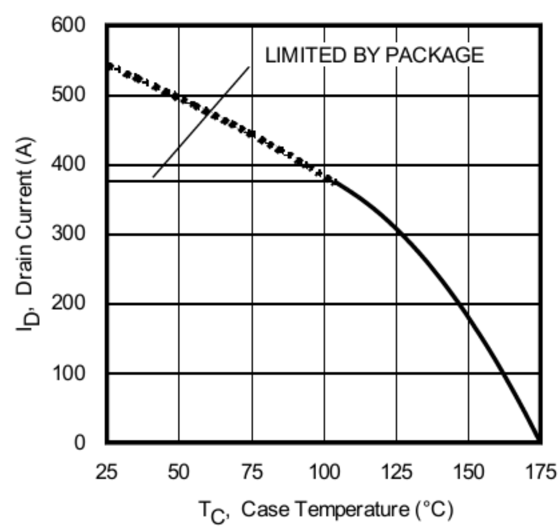


Fig 12. Maximum Drain Current vs. Case Temperature

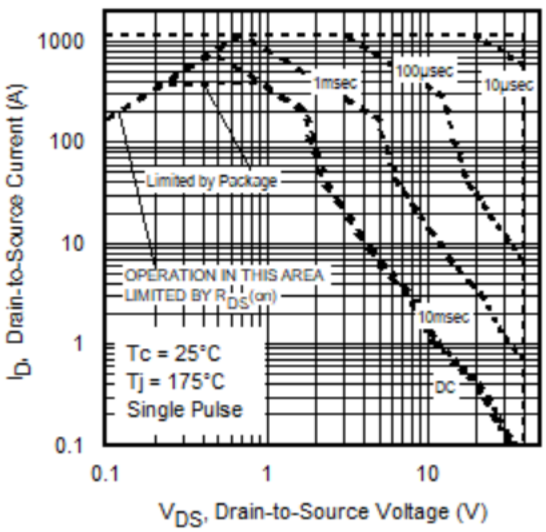


Fig 13. Maximum Safe Operating Area

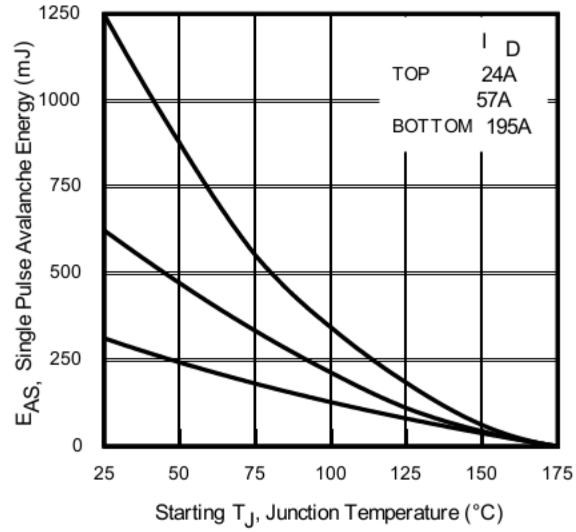


Fig 14. Maximum Avalanche Energy vs. Temperature

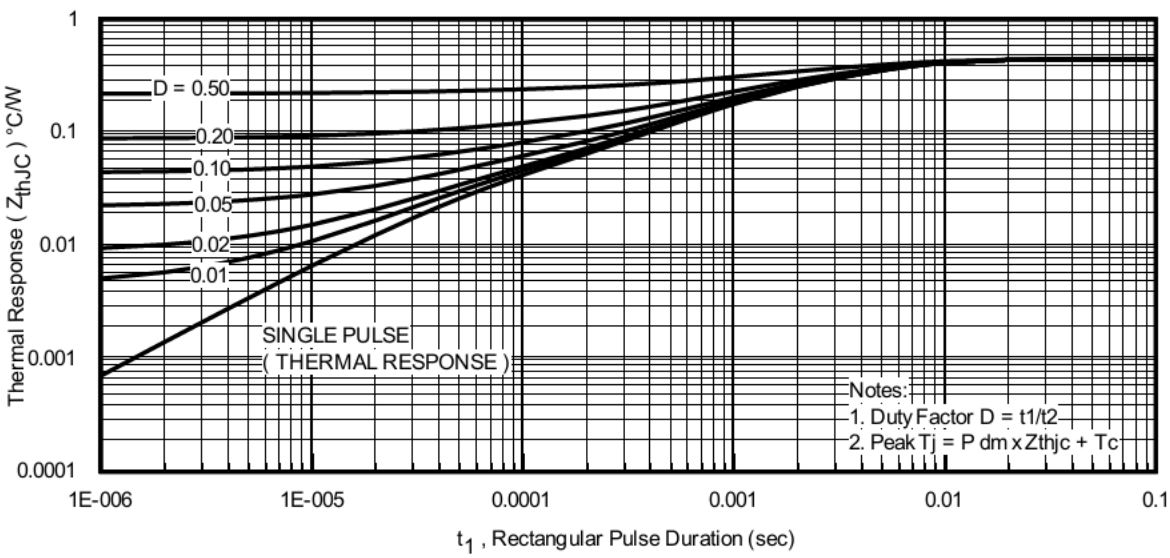


Fig 15. Maximum Effective Transient Thermal Impedance, Junction-to-Case

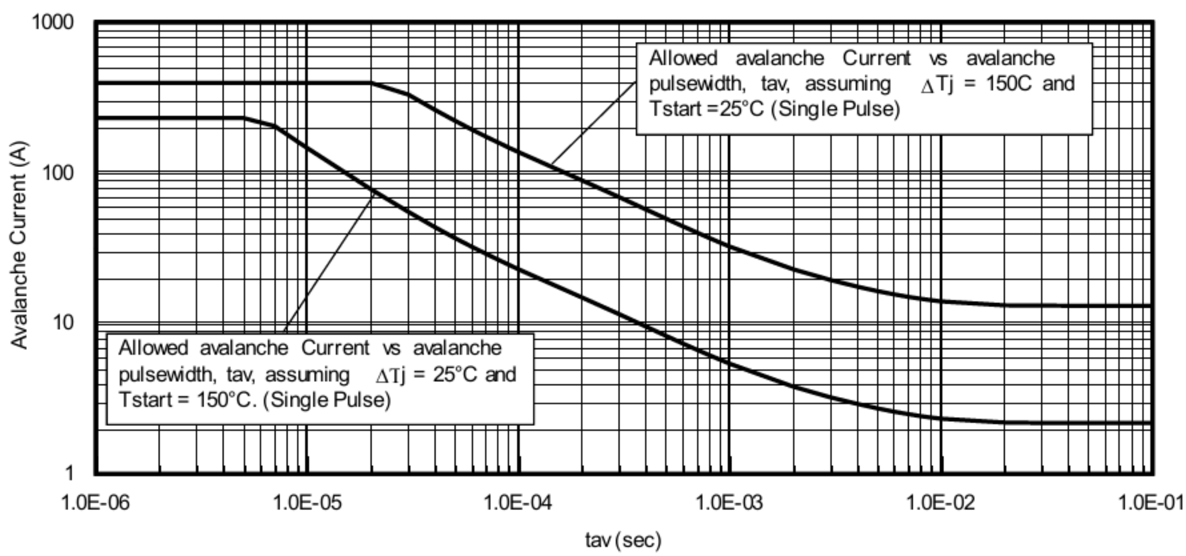
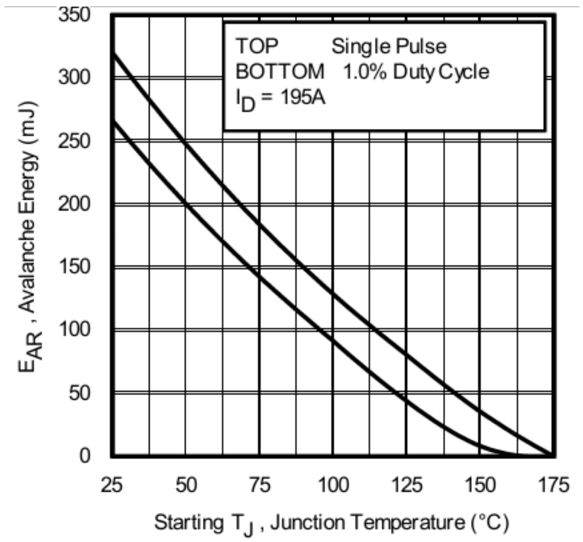


Fig 16. Typical Avalanche Current vs. Pulse Width



Notes on Repetitive Avalanche Curves , Figures 16, 17:
(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 18a, 18b.
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 16, 17).
   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 15)

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

Fig 17.

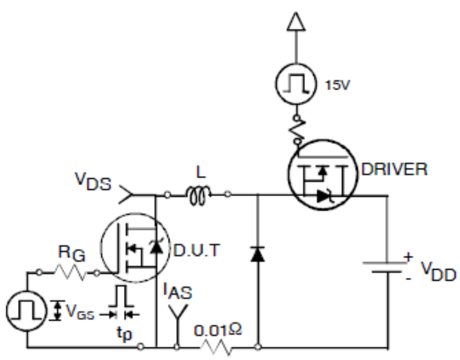
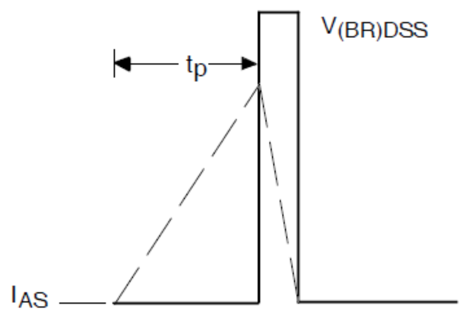


Fig 18a. Unclamped Inductive Test Circuit



Fig

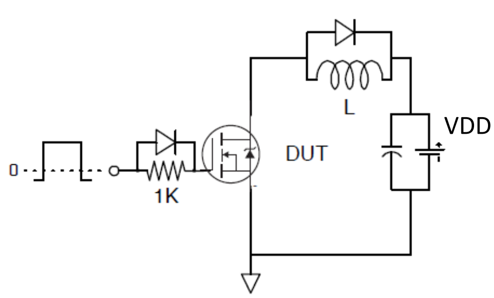


Fig 19a. Gate Charge Test Circuit

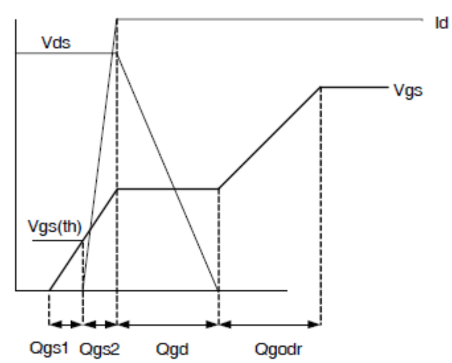


Fig 19b. Gate Charge Waveform

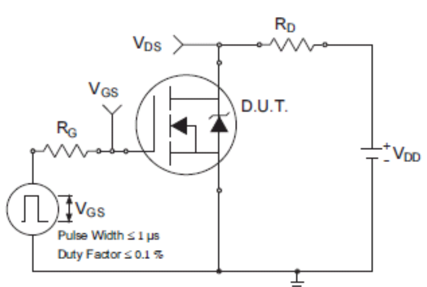


Fig 20a. Switching Time Test Circuit

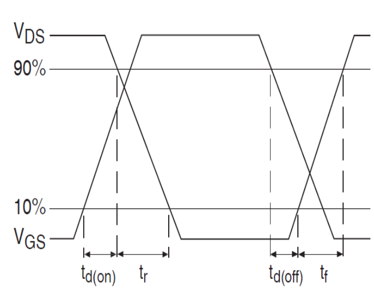
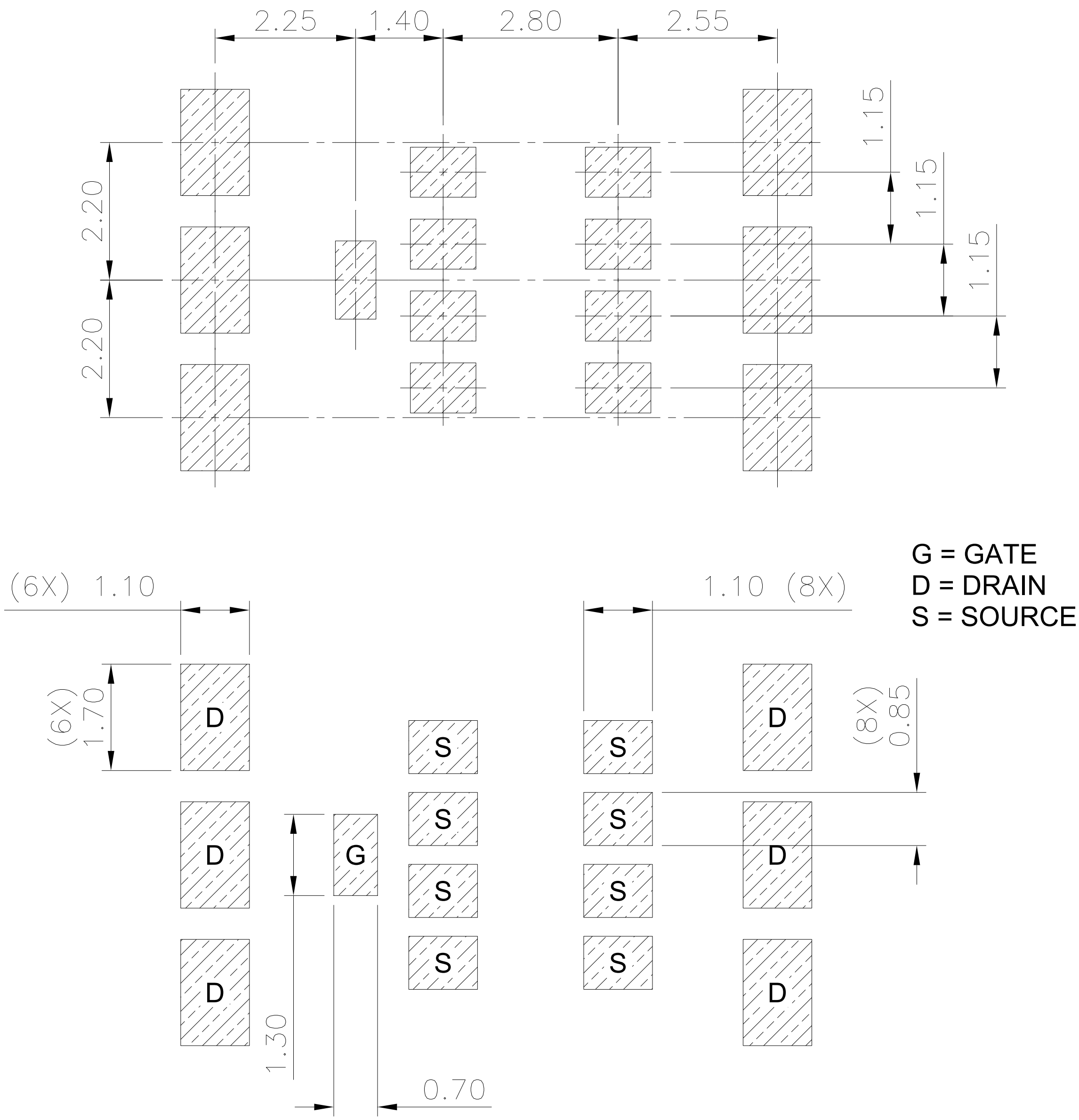


Fig 20b. Switching Time Waveforms

DirectFET® Board Footprint, L8 Outline
(Large Size Can, 8-Source Pads)

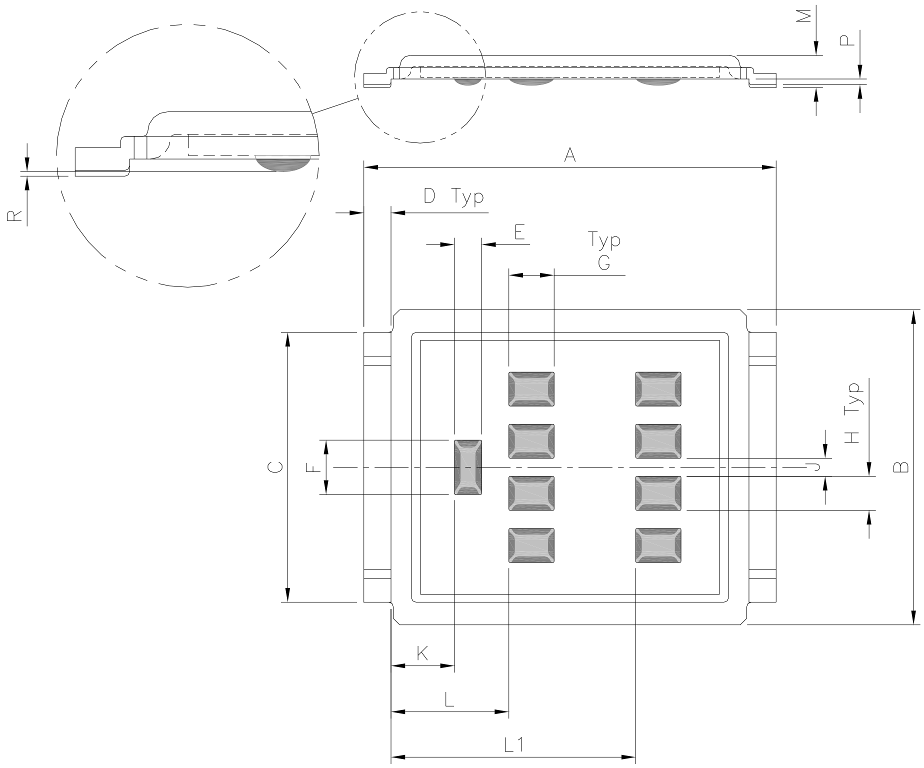
Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET. This includes all recommendations for stencil and substrate designs.



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

DirectFET® Outline Dimension, L8 Outline (Large Size Can, 8-Source Pads)

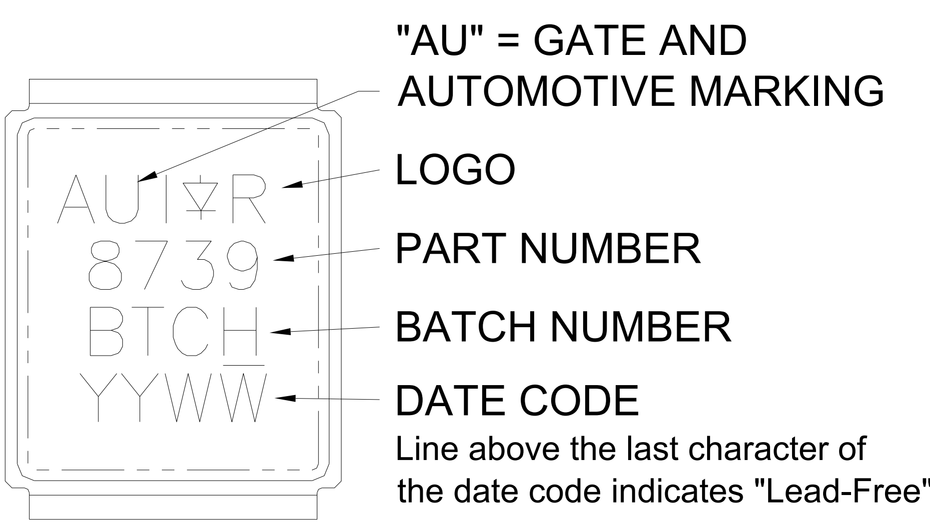
Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET. This includes all recommendations for stencil and substrate designs.



DIMENSIONS				
	METRIC		IMPERIAL	
CODE	MIN	MAX	MIN	MAX
A	9.05	9.15	0.356	0.360
B	6.85	7.10	0.270	0.280
C	5.90	6.00	0.232	0.236
D	0.55	0.65	0.022	0.026
E	0.58	0.62	0.023	0.024
F	1.18	1.22	0.046	0.048
G	0.98	1.02	0.039	0.040
H	0.73	0.77	0.029	0.030
J	0.38	0.42	0.015	0.017
K	1.35	1.45	0.053	0.057
L	2.55	2.65	0.100	0.104
L1	5.35	5.45	0.211	0.215
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

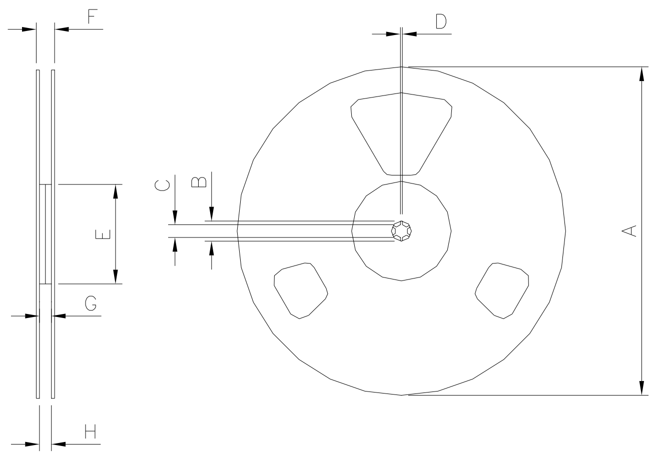
Dimensions are shown in millimeters (inches)

DirectFET® Part Marking



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

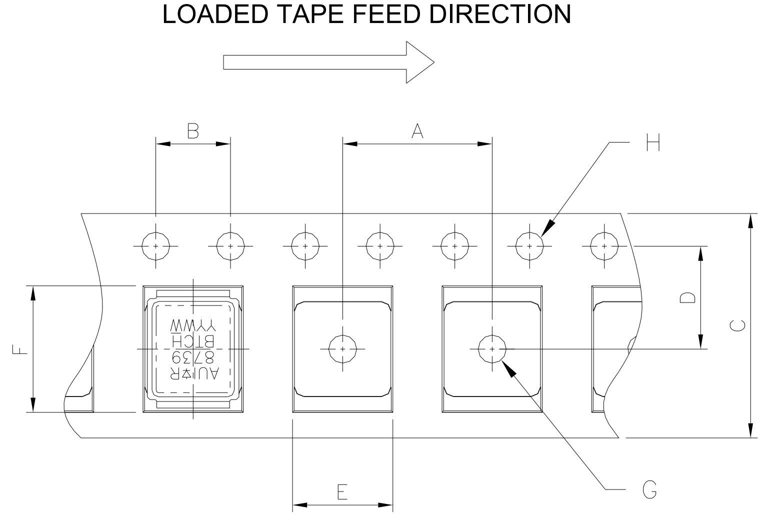
DirectFET® Tape & Reel Dimension (Showing component orientation)



NOTE: Controlling dimensions in mm
Std reel quantity is 4000 parts, ordered as AUIRF8739L2TR.

REEL DIMENSIONS				
STANDARD OPTION **(QTY 4000)**				
	METRIC		IMPERIAL	
CODE	MIN	MAX	MIN	MAX
A	330.00	N.C	12.992	N.C
B	20.20	N.C	0.795	N.C
C	12.80	13.20	0.504	0.520
D	1.50	N.C	0.059	N.C
E	99.00	100.00	3.900	3.940
F	N.C	22.40	N.C	0.880
G	16.40	18.40	0.650	0.720
H	15.90	19.40	0.630	0.760

LOADED TAPE FEED DIRECTION



NOTE: CONTROLLING DIMENSIONS IN MM

DIMENSIONS				
	METRIC		IMPERIAL	
CODE	MIN	MAX	MIN	MAX
A	11.90	12.10	4.69	0.476
B	3.90	4.10	0.154	0.161
C	15.90	16.30	0.623	0.642
D	7.40	7.60	0.291	0.299
E	7.20	7.40	0.283	0.291
F	9.90	10.10	0.390	0.398
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		Automotive (per AEC-Q101)	
		Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
Moisture Sensitivity Level		DirectFET2 L-CAN	MSL1
ESD	Machine Model	Class M4 (+/- 800V)††	
		AEC-Q101-002	
	Human Body Model	Class H2 (+/- 4000V)††	
		AEC-Q101-001	
RoHS Compliant		Yes	

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

†† Highest passing voltage.

Revision History

Date	Rev.	Comments
02/17/2015	2.0	• Final data sheet
06/15/2022	2.1	• Update Fig.13_SOA curve • Corrected typo on Absolute Maximum Ratings Table from "VGS" to "VDS" on page 1

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°C, L = 0.016mH, R_G = 50Ω, I_{AS} = 195A, Vgs = 20V.
⑦ Pulse width ≤ 400µs; duty cycle ≤ 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_θ is measured at T_J of approximately 90°C.
** Starting T_J = 25°C, L = 0.1mH, R_G = 50Ω, I_{AS} = 288A, Vgs = 20V

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

http://www.irf.com/technical-info/

WORLD HEADQUARTERS:

101 N. Sepulveda Blvd., El Segundo, California 90245

Tel: (310) 252-7105