HEXFET® POWER MOSFET

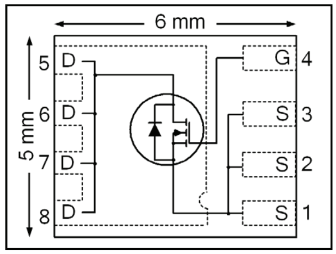
V_{DSS}	**40V**
$R_{DS(on)}$ **typ.**	**3.6mΩ**
max	**4.6mΩ**
I_D **(Silicon Limited)**	**84A**

Features

- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to Tjmax
- Lead-Free, RoHS Compliant
- Automotive Qualified *

Description

Specifically designed for Automotive applications, this HEXFET® Power MOSFET utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this design are a 175°C junction operating temperature, fast switching speed and improved repetitive avalanche rating. These features combine to make this product an extremely efficient and reliable device for use in Automotive and wide variety of other applications.



PQFN 5X6 mm

G	D	S
Gate	Drain	Source

Applications

- Motor Control
- Reverse Battery Protection
- Heavy Loads

Base Part Number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
AUIRFN8401	PQFN 5mm x 6mm	Tape and Reel	4000	AUIRFN8401TR

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
I_D @ $T_{C(Bottom)}$ = 25°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)	84	A
I_D @ $T_{C(Bottom)}$ = 100°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)	59	
I_{DM}	Pulsed Drain Current ①	336	
P_D @T_A = 25°C	Power Dissipation	4.2	W
P_D @$T_{C(Bottom)}$ = 25°C	Power Dissipation	63	
	Linear Derating Factor	0.028	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy (Thermally Limited) ②	69	mJ
E_{AS} (Tested)	Single Pulse Avalanche Energy ②	93	
I_{AR}	Avalanche Current ①	See Fig. 14, 15, 22a, 22b	A
E_{AR}	Repetitive Avalanche Energy ①		mJ
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C

HEXFET® is a registered trademark of International Rectifier.
*Qualification standards can be found at http://www.irf.com/

Thermal Resistance

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$ (Bottom)	Junction-to-Case ④	——	2.4	°C/W
$R_{\theta JC}$ (Top)	Junction-to-Case ④	——	34	
$R_{\theta JA}$	Junction-to-Ambient ⑤	——	36	
$R_{\theta JA}$ (<10s)	Junction-to-Ambient ⑤	——	23	

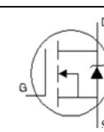
Static Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

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	——	35	——	mV/°C	Reference to 25°C, I_D = 1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	——	3.6	4.6	mΩ	V_{GS} = 10V, I_D = 50A
$V_{GS(th)}$	Gate Threshold Voltage	2.2	3.0	3.9	V	V_{DS} = V_{GS}, I_D = 50μA
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	——	2.2	——	Ω	

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
gfs	Forward Transconductance	144	——	——	S	V_{DS} = 10V, I_D = 50A
Q_g	Total Gate Charge	——	44	66	nC	I_D = 50A
Q_{gs}	Gate-to-Source Charge	——	13	——		V_{DS} = 20V
Q_{gd}	Gate-to-Drain ("Miller") Charge	——	15	——		V_{GS} = 10V
Q_{sync}	Total Gate Charge Sync. (Q_g - Q_{gd})	——	29	——		
$t_{d(on)}$	Turn-On Delay Time	——	6.1	——	ns	V_{DD} = 20V
t_r	Rise Time	——	13	——		I_D = 30A
$t_{d(off)}$	Turn-Off Delay Time	——	22	——		R_G = 2.7Ω
t_f	Fall Time	——	12	——		V_{GS} = 10V ③
C_{iss}	Input Capacitance	——	2170	——	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	——	340	——		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	——	220	——		f = 1.0 MHz
C_{oss} eff. (ER)	Effective Output Capacitance (Energy Related)	——	422	——		V_{GS} = 0V, V_{DS} = 0V to 32V ⑦
C_{oss} eff. (TR)	Effective Output Capacitance (Time Related)	——	502	——		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)	——	——	84	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	——	——	336		
V_{SD}	Diode Forward Voltage	——	0.9	1.3	V	T_J = 25°C, I_S = 50A, V_{GS} = 0V ③
dv/dt	Peak Diode Recovery	——	7.8	——	V/ns	T_J = 175°C, I_S= 50A, V_{DS} = 40V
t_{rr}	Reverse Recovery Time	——	20	——	ns	T_J = 25°C; V_R = 34V, I_F = 50A, di/dt = 100A/μs③
		——	22	——		T_J = 125°C
Q_{rr}	Reverse Recovery Charge	——	12	——	nC	T_J = 25°C
		——	15	——		T_J = 125°C
I_{RRM}	Reverse Recovery Current	——	1.1	——	A	T_J = 25°C

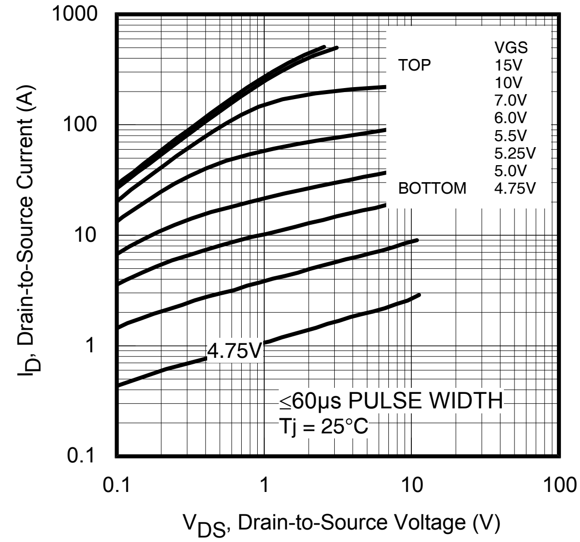


Fig. 1 Typical Output Characteristics

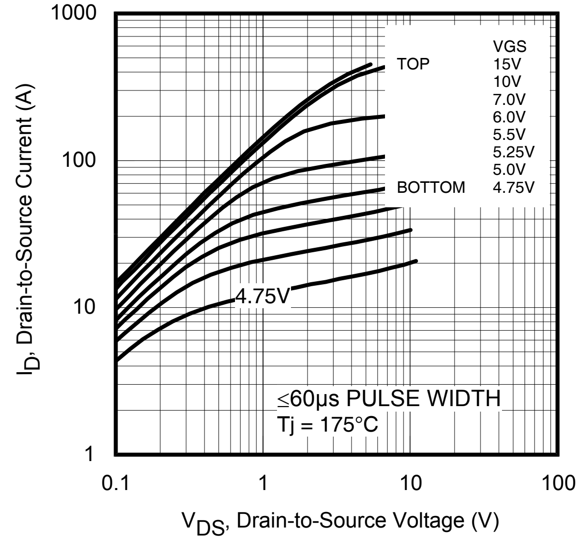


Fig. 2 Typical Output Characteristics

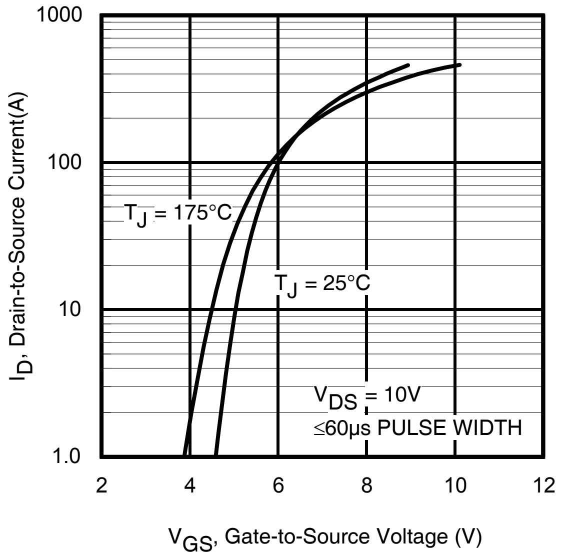


Fig. 3 Typical Transfer Characteristics

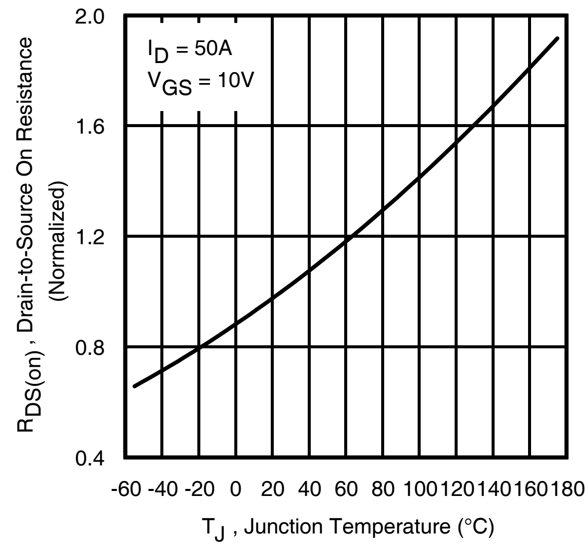


Fig. 4 Normalized On-Resistance vs. Temperature

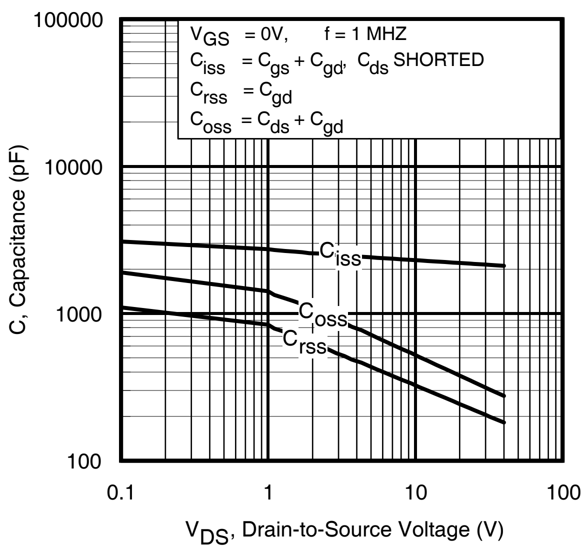


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

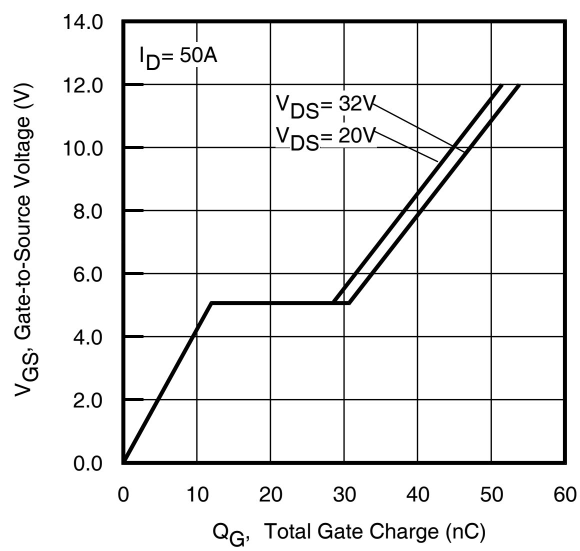


Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage

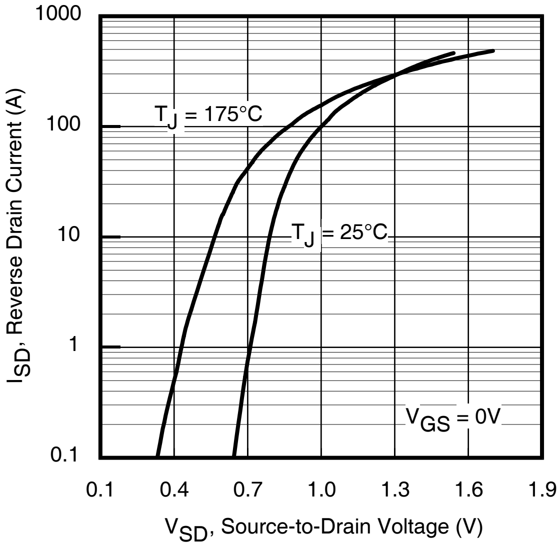


Fig. 7 Typical Source-to-Drain Diode

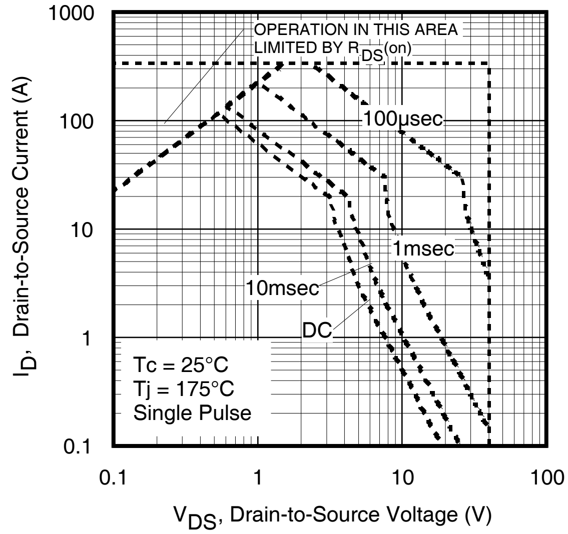


Fig 8. Maximum Safe Operating Area

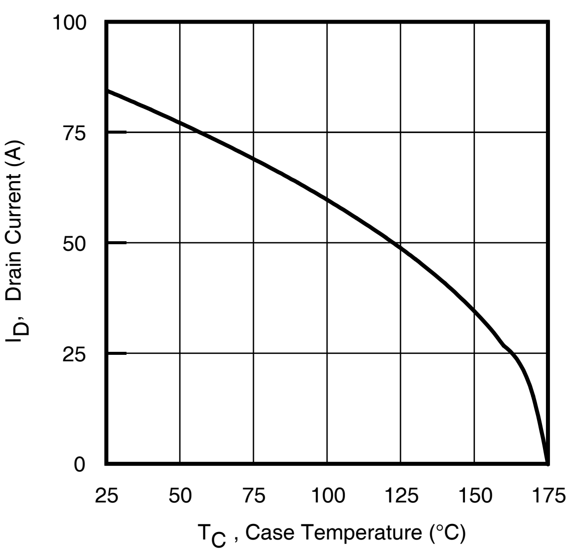


Fig 9. Maximum Drain Current vs. Case Temperature

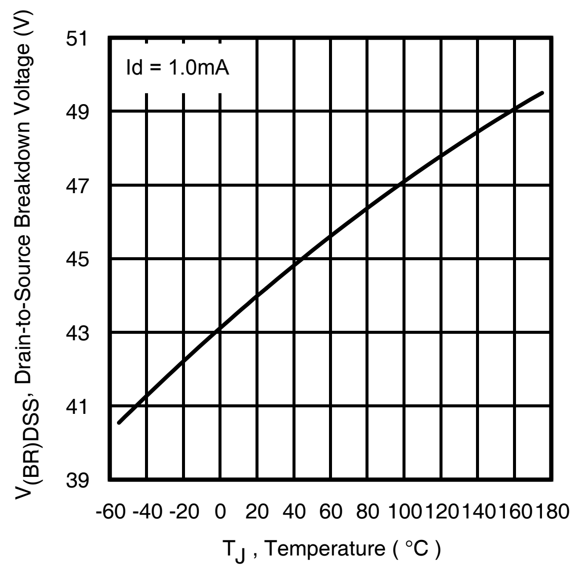


Fig 10. Drain-to-Source Breakdown Voltage

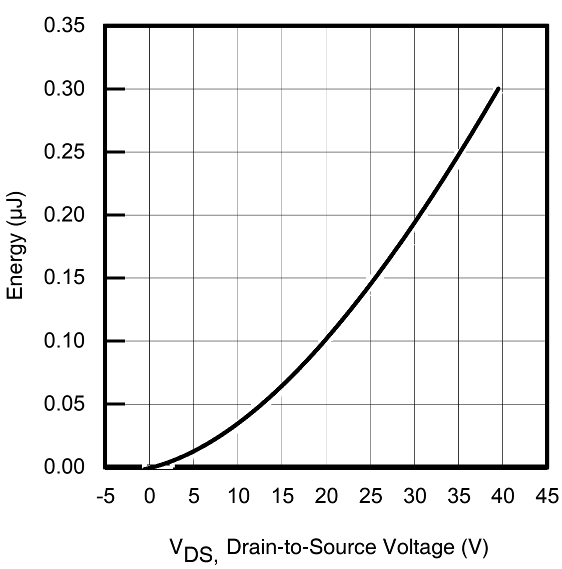


Fig 11. Typical Coss Stored Energy

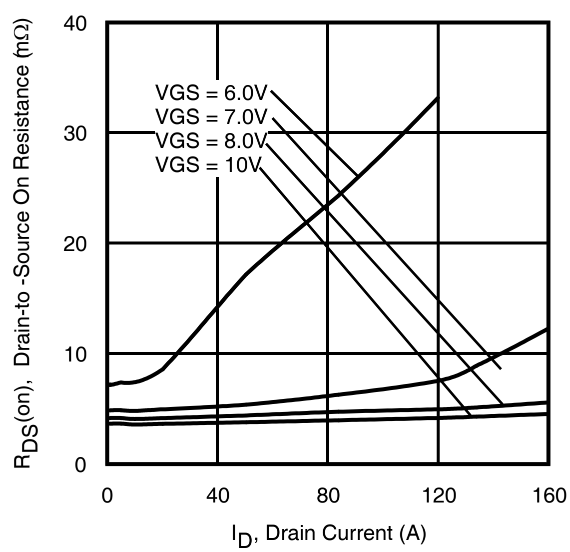


Fig 12. Typical On-Resistance vs. Drain Current

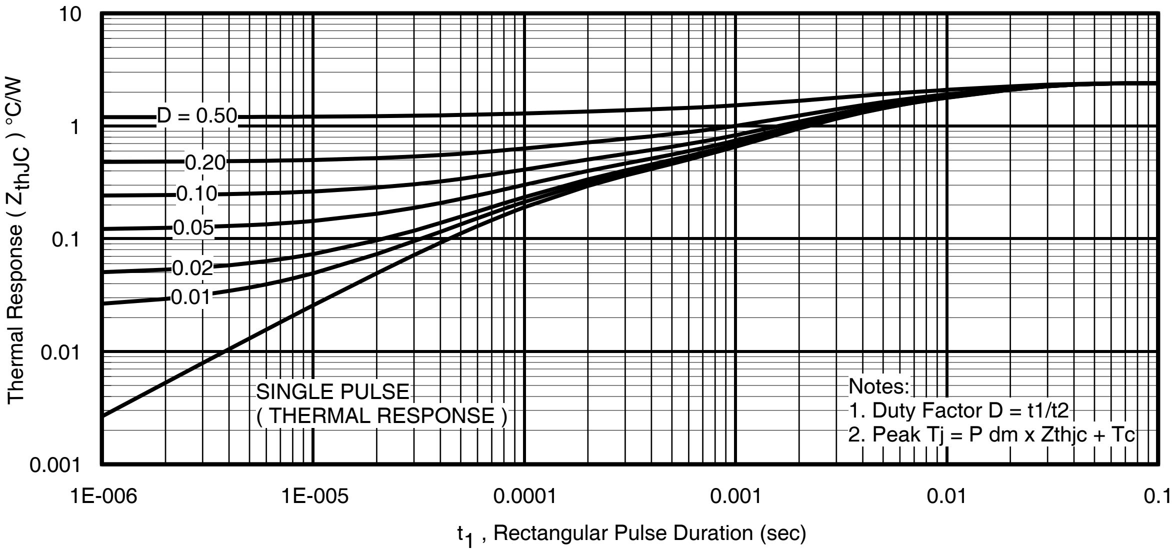


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

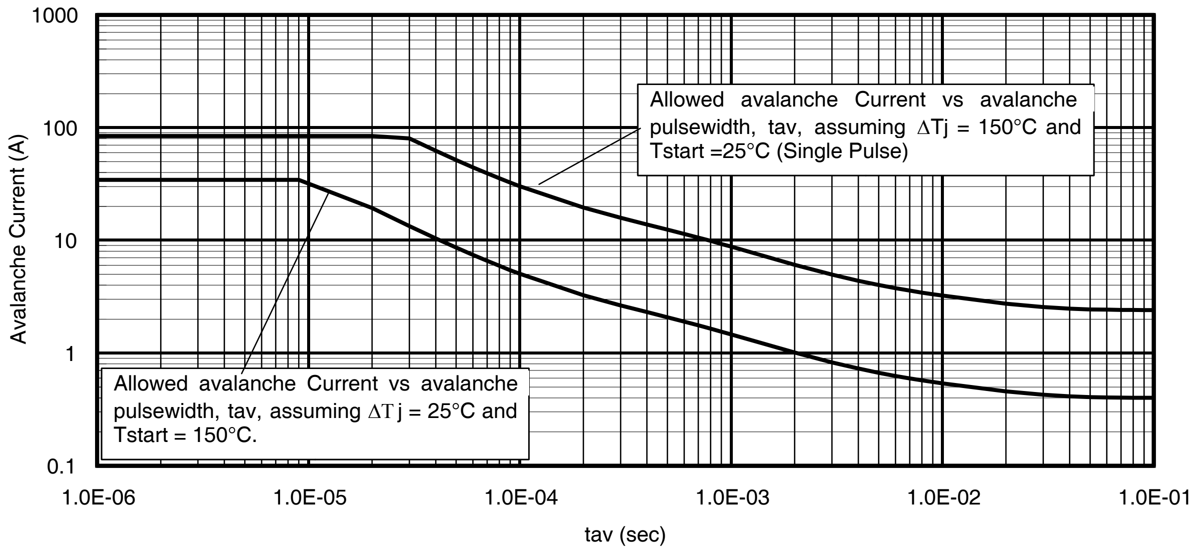


Fig 14. Typical Avalanche Current vs. Pulse Width

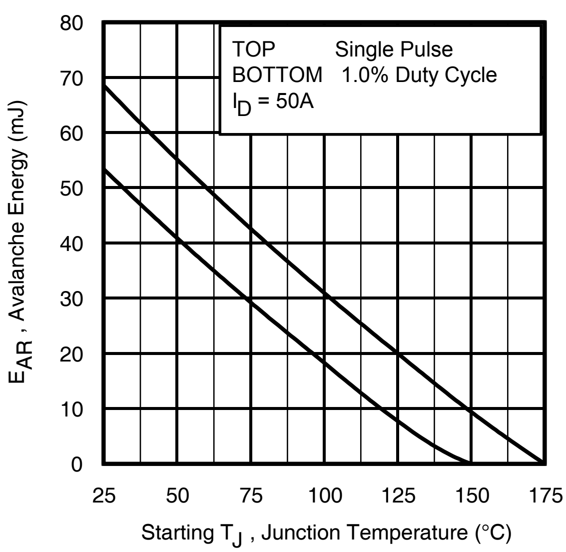


Fig 15. Maximum Avalanche Energy vs. Temperature

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)

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

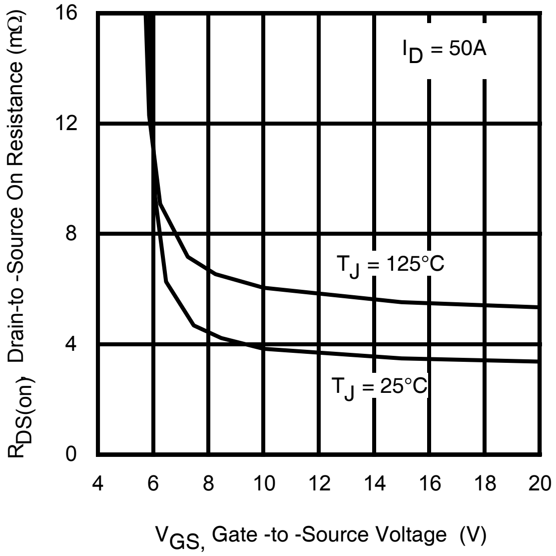


Fig 16. Typical On-Resistance vs. Gate Voltage

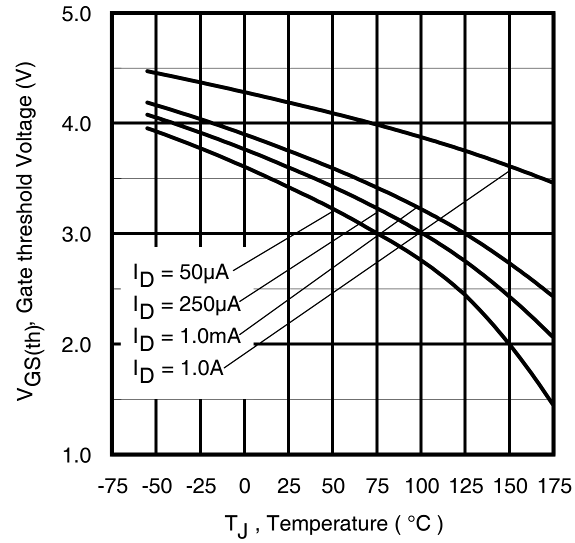


Fig 17. Threshold Voltage vs. Temperature

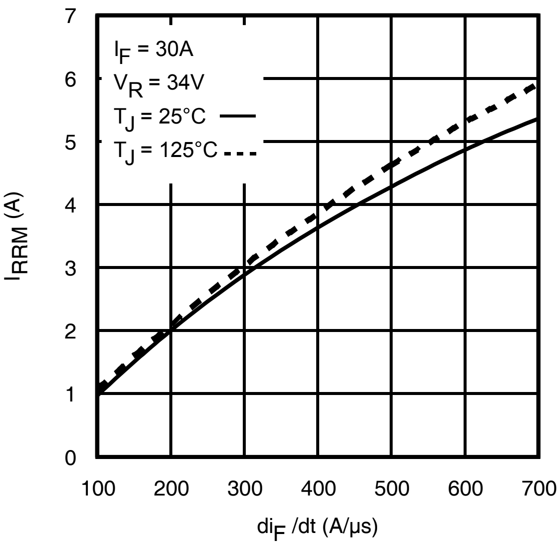


Fig. 18 - Typical Recovery Current vs. dif/dt

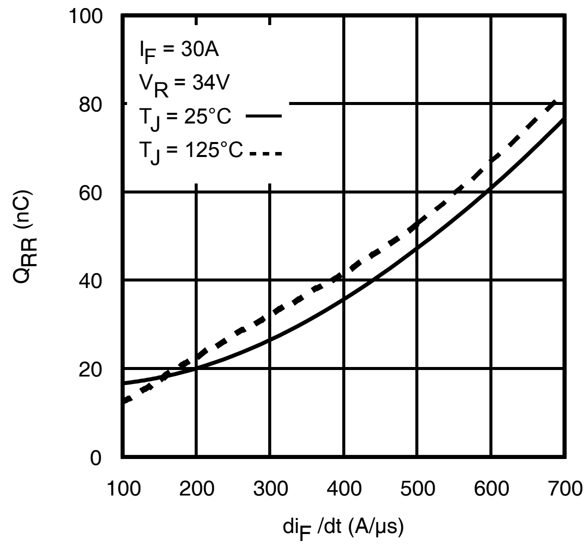


Fig. 19 - Typical Stored Charge vs. dif/dt

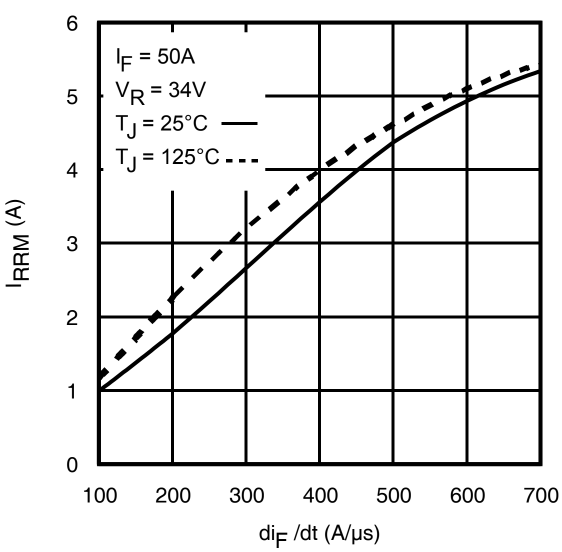


Fig. 20 - Typical Recovery Current vs. dif/dt

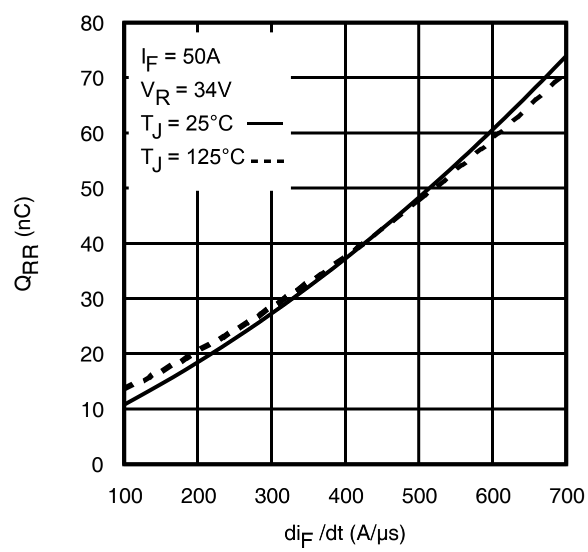


Fig. 21 - Typical Stored Charge vs. dif/dt

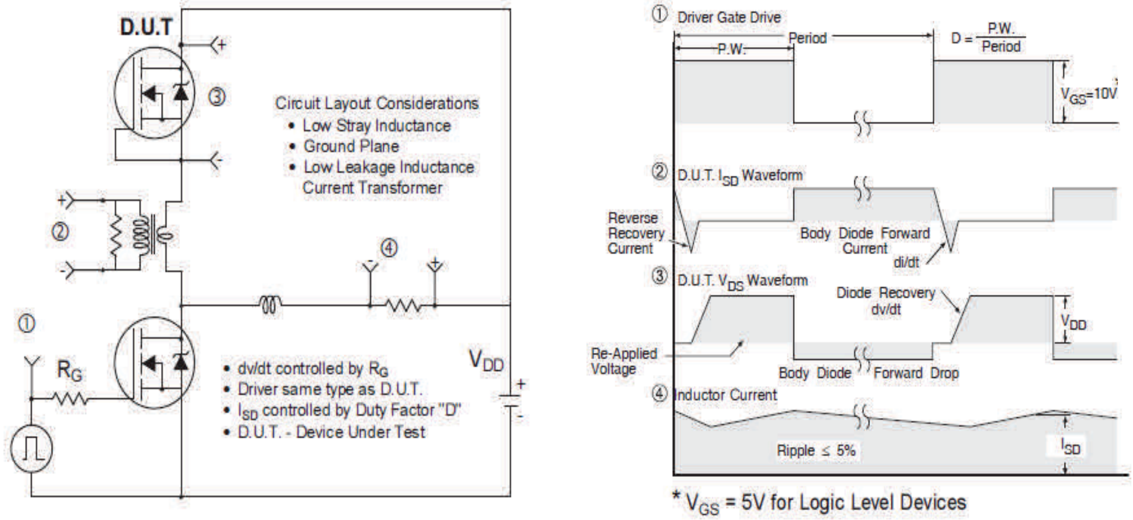


Fig 22. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

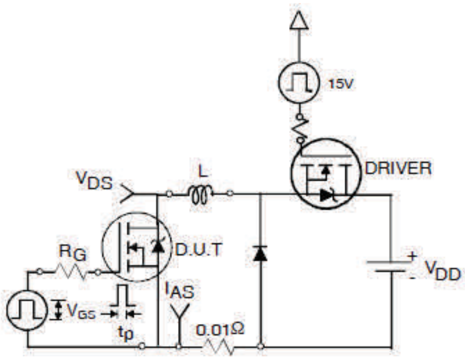


Fig 22a. Unclamped Inductive Test Circuit

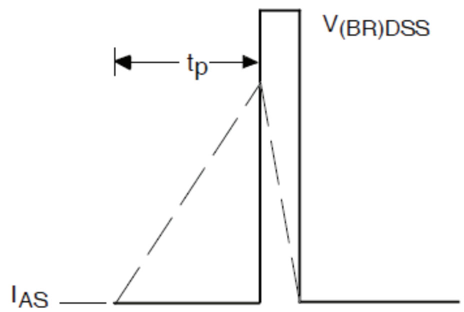


Fig 22b. Unclamped Inductive Waveforms

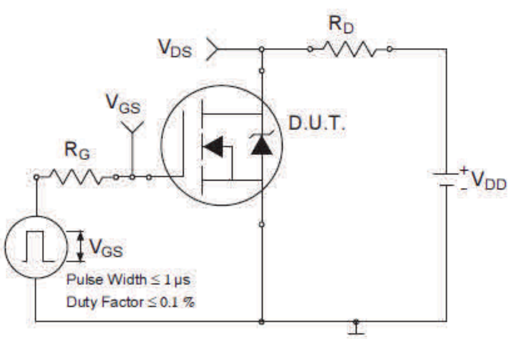


Fig 23a. Switching Time Test Circuit

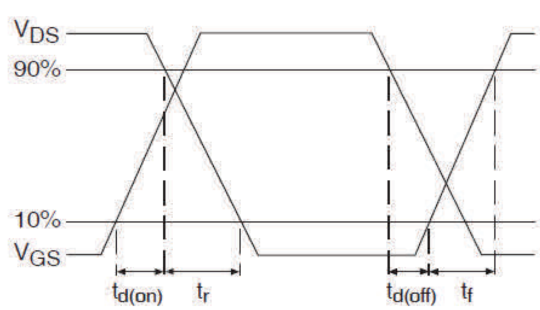


Fig 23b. Switching Time Waveforms

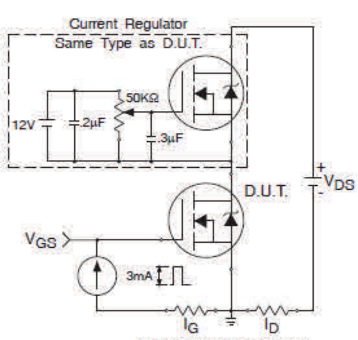


Fig 24a. Gate Charge Test Circuit

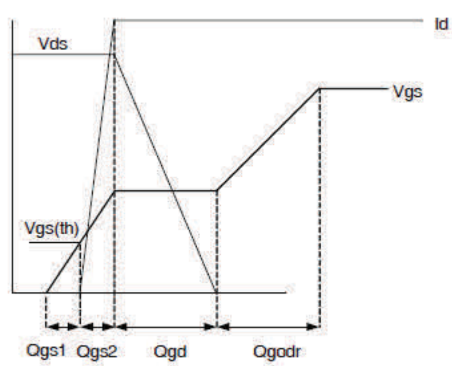
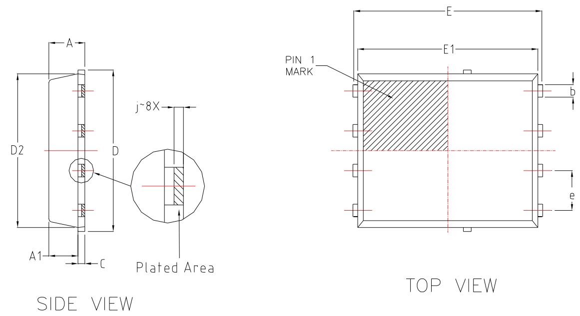
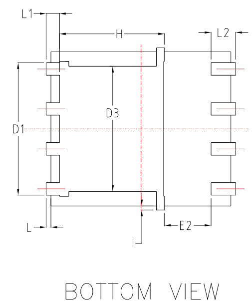


Fig 24b. Gate Charge Waveform

PQFN 5x6 Outline "E" Package Details

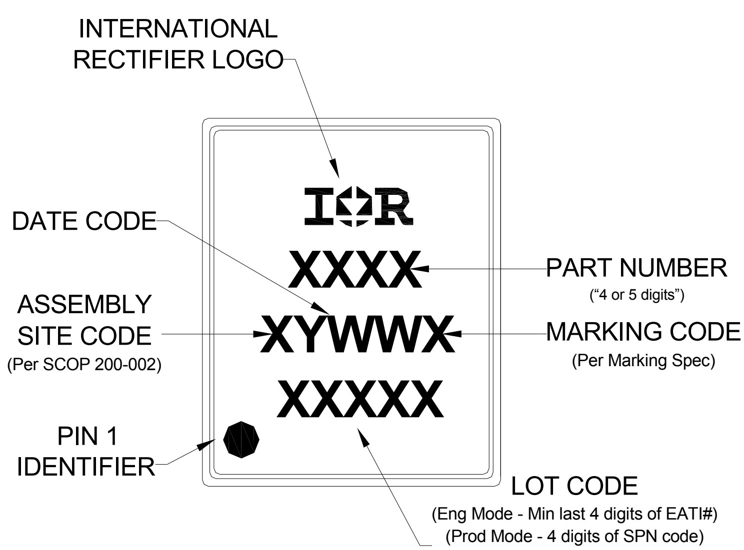


DIM	MM		
	MIN	NOM	MAX
A	0.90	1.10	1.17
A1	0.824	0.897	0.97
b	0.33	0.41	0.50
c	0.150	0.20	0.250
D	4.80	4.98	5.15
D1	3.91	4.22	4.36
D2	4.80	4.90	5.00
D3	3.85	4.00	4.15
E	5.90	6.05	6.15
E1	5.65	5.76	5.85
E2	1.10	/	/
e	1.27 BSC		
L	0.05	0.15	0.25
L1	0.38	0.425	0.50
L2	0.51	0.785	0.86
H	3.25	3.35	3.58
I	0	/	0.18
j	0.1015 BSC		



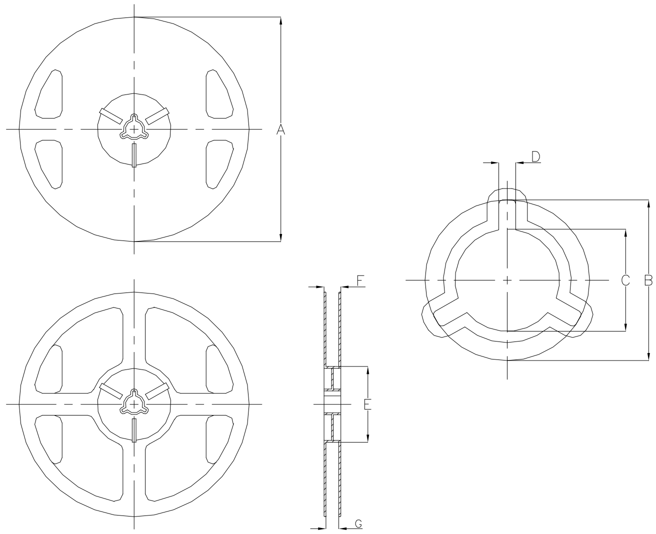
For footprint and stencil design recommendations, please refer to application note AN-1136 at
http://www.irf.com/technical-info/appnotes/an-1136.pdf
For visual inspection recommendations, please refer to application note AN-1154 at
http://www.irf.com/technical-info/appnotes/an-1154.pdf

PQFN 5x6 Outline "E" Part Marking

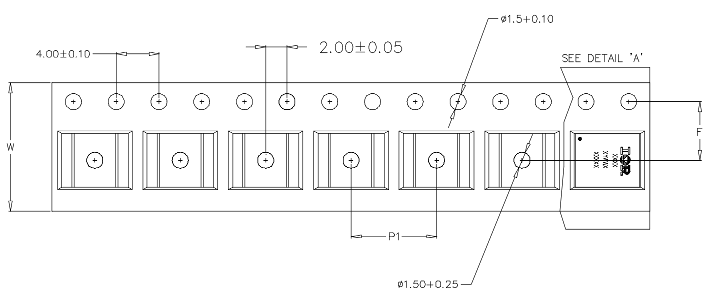


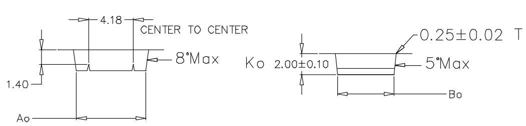
Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

PQFN 5x6 Outline "E" Tape and Reel

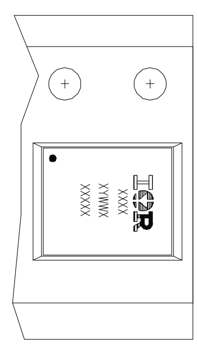


REEL DIMENSIONS				
STANDARD OPTION **(QTY 4000)** TR				
	METRIC		IMPERIAL	
CODE	MIN	MAX	MIN	MAX
A	329.5	330.5	12.972	13.011
B	20.9	21.5	0.823	0.846
C	12.8	13.5	0.504	0.532
D	1.7	2.3	0.067	0.091
E	97	99	3.819	3.898
F	Ref	17.4		
G	13	14.5	0.512	0.571





DETAIL 'A'



Ao	6.50 ±0.10
Bo	5.28 ±0.10
F	5.50 ±0.05
P1	8.00 ±0.10
W	12.00 $^{+0.30}_{-0.10}$

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		PQFN 5mm x 6mm	MSL1
ESD	Human Body Model	Class H1B (+/- 1000V)†† AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 2000V)†† AEC-Q101-005	
RoHS Compliant		Yes	

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

†† Highest passing voltage.

Notes:

① Repetitive rating; pulse width limited by max. junction temperature.

② Starting T_J = 25°C, L =0.055mH, R_G = 50Ω, I_{AS} = 50A.

③ Pulse width ≤ 400µs; duty cycle ≤ 2%.

④ R_θ is measured at TJ of approximately 90°C.

⑤ When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994: http://www.irf.com/technical-info/appnotes/an-994.pdf

⑥ Coss eff. (TR) is a fixed capacitance that gives the same charging time as Coss while VDS is rising from 0 to 80% VDSS.

⑦ Coss eff. (ER) is a fixed capacitance that gives the same energy as Coss while VDS is rising from 0 to 80% VDSS.

IMPORTANT NOTICE

Unless specifically designated for the automotive market, International Rectifier Corporation and its subsidiaries (IR) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or services without notice. Part numbers designated with the "AU" prefix follow automotive industry and / or customer specific requirements with regards to product discontinuance and process change notification. All products are sold subject to IR's terms and conditions of sale supplied at the time of order acknowledgment.

IR warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with IR's standard warranty. Testing and other quality control techniques are used to the extent IR deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

IR assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using IR components. To minimize the risks with customer products and applications, customers should provide adequate design and operating safeguards.

Reproduction of IR information in IR data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alterations is an unfair and deceptive business practice. IR is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of IR products or serviced with statements different from or beyond the parameters stated by IR for that product or service voids all express and any implied warranties for the associated IR product or service and is an unfair and deceptive business practice. IR is not responsible or liable for any such statements.

IR products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or in other applications intended to support or sustain life, or in any other application in which the failure of the IR product could create a situation where personal injury or death may occur. Should Buyer purchase or use IR products for any such unintended or unauthorized application, Buyer shall indemnify and hold International Rectifier and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that IR was negligent regarding the design or manufacture of the product.

Only products certified as military grade by the Defense Logistics Agency (DLA) of the US Department of Defense, are designed and manufactured to meet DLA military specifications required by certain military, aerospace or other applications. Buyers acknowledge and agree that any use of IR products not certified by DLA as military-grade, in applications requiring military grade products, is solely at the Buyer's own risk and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

IR products are neither designed nor intended for use in automotive applications or environments unless the specific IR products are designated by IR as compliant with ISO/TS 16949 requirements and bear a part number including the designation "AU". Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, IR will not be responsible for any failure to meet such requirements.

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