International
IOR Rectifier

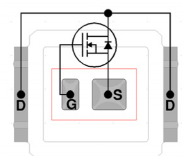
AUTOMOTIVE GRADE

AUIRF7665S2TR
AUIRF7665S2TR1

DirectFET™ Power MOSFET ②

$V_{(BR)DSS}$		**100V**
$R_{DS(on)}$	typ.	**51mΩ**
	max.	**62mΩ**
$R_{G\ (typical)}$		**3.5Ω**
$Q_{g\ (typical)}$		**8.3nC**

- Advanced Process Technology
- Optimized for Class D Audio Amplifier Applications
- Low Rds(on) for Improved Efficiency
- Low Qg for Better THD and Improved Efficiency
- Low Qrr for Better THD and Lower EMI
- Low Parasitic Inductance for Reduced Ringing and Lower EMI
- Delivers up to 100W per Channel into 8W with No Heatsink
- Dual Sided Cooling
- 175°C Operating Temperature
- Repetitive Avalanche Capability for Robustness and Reliability
- Lead free, RoHS and Halogen free



SB


DirectFET™ ISOMETRIC

Applicable DirectFET Outline and Substrate Outline ①

SB	SC			M2	M4		L4	L6	L8	

Description

The AUIRF7665S2 combines the latest Automotive HEXFET® Power MOSFET Silicon technology with the advanced DirectFET packaging platform to produce a best in class part for Automotive Class D audio amplifier applications. 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 optimizes gate charge, body diode reverse recovery and internal gate resistance to improve key Class D audio amplifier performance factors such as efficiency, THD and EMI. Moreover the DirectFET packaging platform offers low parasitic inductance and resistance when compared to conventional wire bonded SOIC packages which improves EMI performance by reducing the voltage ringing that accompanies current transients.
These features combine to make this MOSFET a highly desirable component in Automotive Class D audio amplifier systems.

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{DS}	Drain-to-Source Voltage	100	V
V_{GS}	Gate-to-Source Voltage	± 20	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)④	14.4	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)④	10.2	
I_D @ T_A = 25°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)③	4.1	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Package Limited)	77	
I_{DM}	Pulsed Drain Current ⑤	58	
P_D @T_C = 25°C	Power Dissipation ④	30	W
P_D @T_A = 25°C	Power Dissipation ③	2.4	
E_{AS}	Single Pulse Avalanche Energy (Thermally Limited) ⑥	37	mJ
$E_{AS(tested)}$	Single Pulse Avalanche Energy (Tested Value) ⑥	56	
I_{AR}	Avalanche Current ⑤	See Fig. 18a,18b,16,17	A
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
$R_{θJA}$	Junction-to-Ambient ③	——	63	°C/W
$R_{θJA}$	Junction-to-Ambient ⑧	12.5	——	
$R_{θJA}$	Junction-to-Ambient ⑨	20	——	
$R_{θJ-Can}$	Junction-to-Can ④⑩	——	5.0	
$R_{θJ-PCB}$	Junction-to-PCB Mounted	1.4	——	
	Linear Derating Factor ④	0.2		W/°C

HEXFET® is a registered trademark of International Rectifier.

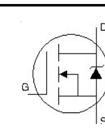
Static @ T_J = 25°C (unless otherwise specified)

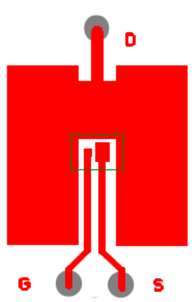
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	100	——	——	V	V_{GS} = 0V, I_D = 250μA
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	——	0.10	——	V/°C	Reference to 25°C, I_D = 1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	——	51	62	mΩ	V_{GS} = 10V, I_D = 8.9A ⑦
$V_{GS(th)}$	Gate Threshold Voltage	3.0	4.0	5.0	V	V_{DS} = V_{GS}, I_D = 25μA
$\Delta V_{GS(th)}/\Delta T_J$	Gate Threshold Voltage Coefficient	——	-13	——	mV/°C	
gfs	Forward Transconductance	8.8	——	——	S	V_{DS} = 25V, I_D = 8.9A
$R_{G(int)}$	Internal Gate Resistance	——	3.5	5.0	Ω	
I_{DSS}	Drain-to-Source Leakage Current	——	——	5	μA	V_{DS} = 100V, V_{GS} = 0V
		——	——	250		V_{DS} = 80V, 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 @ T_J = 25°C (unless otherwise specified)

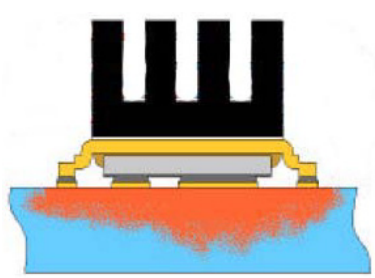
	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge	——	8.3	13	nC	V_{DS} = 50V
Q_{gs1}	Pre-Vth Gate-to-Source Charge	——	1.9	——		V_{GS} = 10V
Q_{gs2}	Post-Vth Gate-to-Source Charge	——	0.77	——		I_D = 8.9A
Q_{gd}	Gate-to-Drain Charge	——	3.2	——		See Fig. 11
Q_{godr}	Gate Charge Overdrive	——	2.4	——		
Q_{sw}	Switch Charge (Q_{gs2} + Q_{gd})	——	4.0	——		
Q_{oss}	Output Charge	——	4.7	——	nC	V_{DS} = 16V, V_{GS} = 0V
$t_{d(on)}$	Turn-On Delay Time	——	3.8	——	ns	V_{DD} = 50V
t_r	Rise Time	——	6.4	——		I_D = 8.9A
$t_{d(off)}$	Turn-Off Delay Time	——	7.1	——		R_G = 6.8Ω
t_f	Fall Time	——	3.6	——		V_{GS} = 10V ⑦
C_{iss}	Input Capacitance	——	515	——	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	——	110	——		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	——	30	——		f = 1.0MHz
C_{oss}	Output Capacitance	——	530	——		V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0MHz
C_{oss}	Output Capacitance	——	70	——		V_{GS} = 0V, V_{DS} = 80V, f = 1.0MHz
C_{oss} eff.	Effective Output Capacitance	——	115	——		V_{GS} = 0V, V_{DS} = 0V to 80V

Diode Characteristics

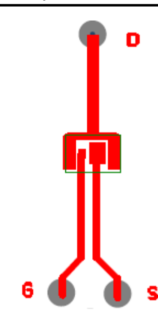
	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	——	——	14.4	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ⑤	——	——	58		
V_{SD}	Diode Forward Voltage	——	——	1.3	V	T_J = 25°C, I_S = 8.9A, V_{GS} = 0V ⑦
t_{rr}	Reverse Recovery Time	——	33	——	ns	T_J = 25°C, I_F = 8.9A, V_{DD} = 25V
Q_{rr}	Reverse Recovery Charge	——	38	——	nC	di/dt = 100A/μs ⑦



③ Surface mounted on 1 in. square Cu (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)

Notes ① through ⑩ are on page 11

Qualification Information†

<table>
<tr><td rowspan="2">Qualification Level</td><td colspan="3">Automotive
(per AEC-Q101) ††</td></tr>
<tr><td colspan="3">Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.</td></tr>
<tr><td colspan="2">Moisture Sensitivity Level</td><td>DFET2</td><td>MSL1</td></tr>
<tr><td rowspan="3">ESD</td><td>Machine Model</td><td colspan="2">Class B
AEC-Q101-002</td></tr>
<tr><td>Human Body Model</td><td colspan="2">Class 2
AEC-Q101-001</td></tr>
<tr><td>Charged Device Model</td><td colspan="2">Class IV
AEC-Q101-005</td></tr>
<tr><td colspan="2">RoHS Compliant</td><td colspan="2">Yes</td></tr>
</table>

† 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.

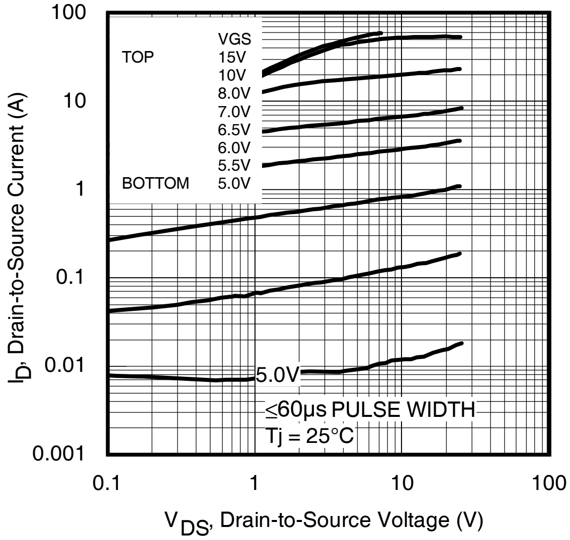


Fig 1. Typical Output Characteristics

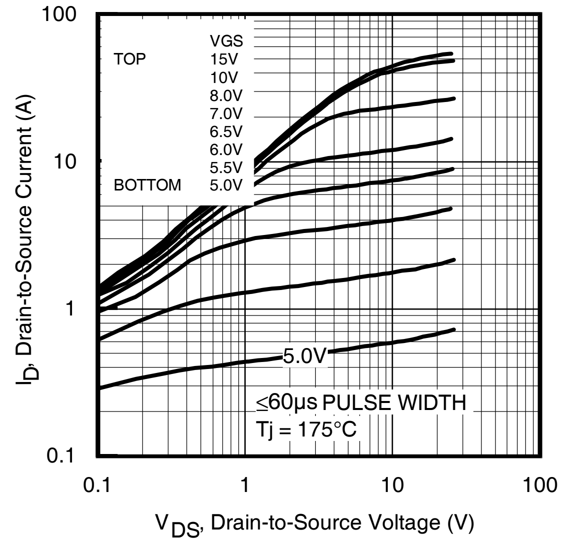


Fig 2. Typical Output Characteristics

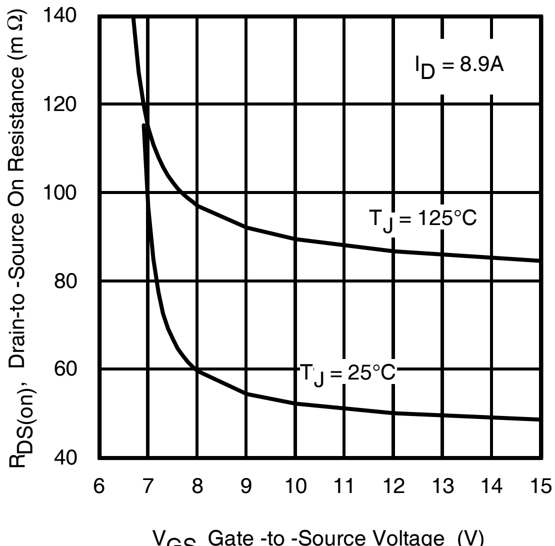


Fig 3. Typical On-Resistance vs. Gate Voltage

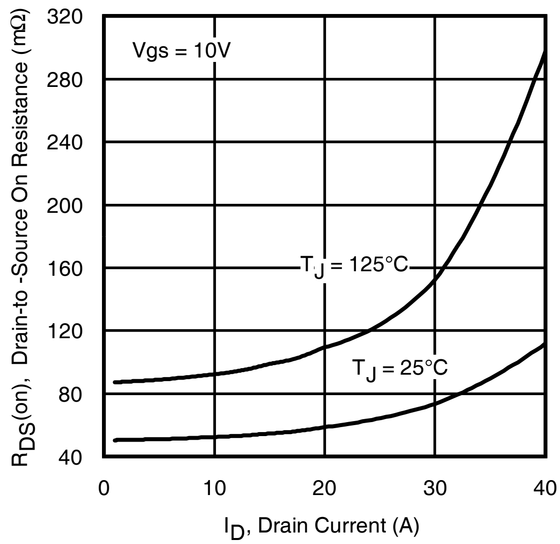


Fig 4. Typical On-Resistance vs. Drain Current

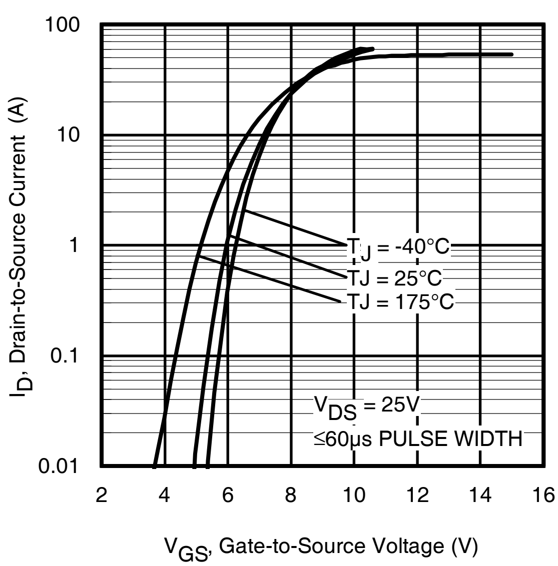


Fig 5. Typical Transfer Characteristics

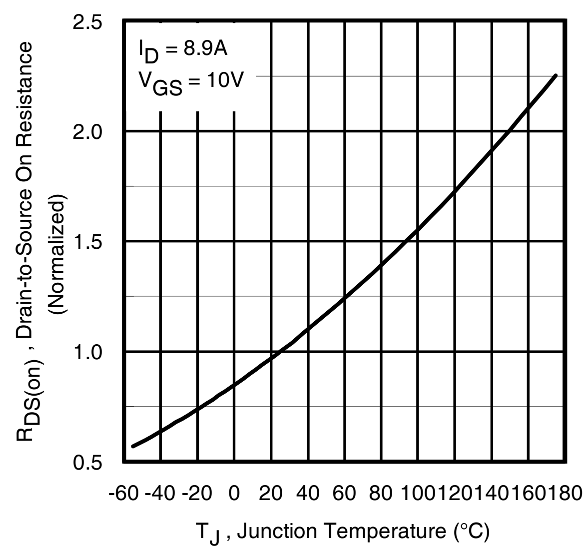


Fig 6. Normalized On-Resistance vs. Temperature

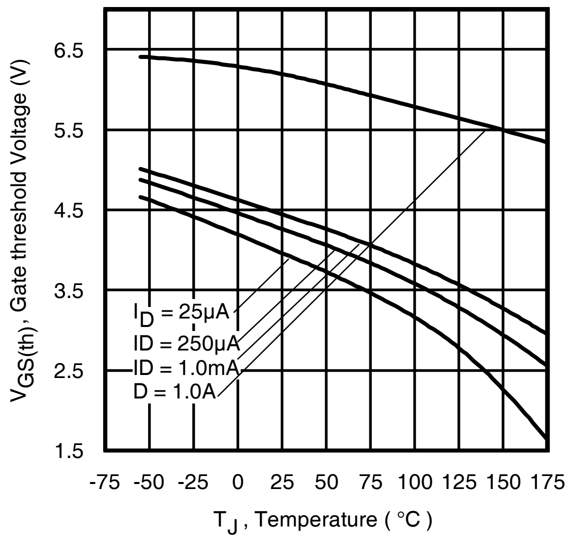


Fig 7. Typical Threshold Voltage vs. Junction Temperature

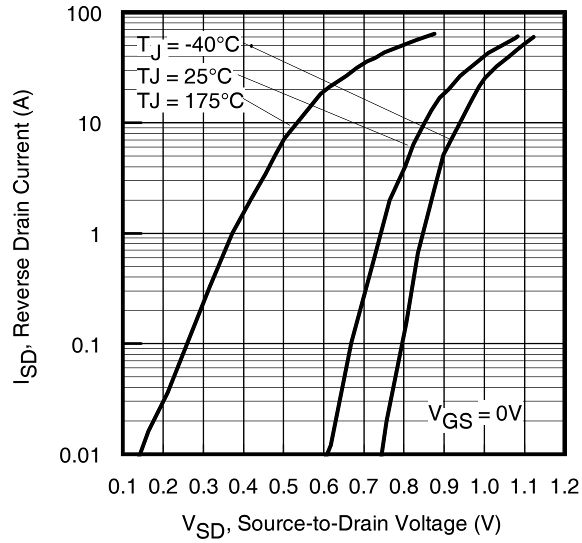


Fig 8. Typical Source-Drain Diode Forward Voltage

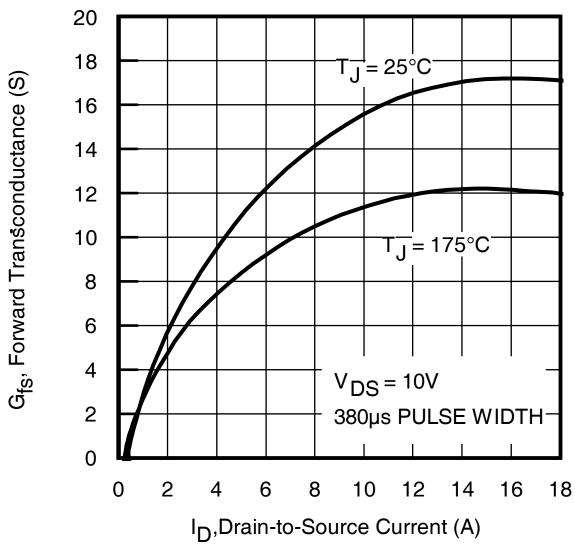


Fig 9. Typical Forward Transconductance Vs. Drain Current

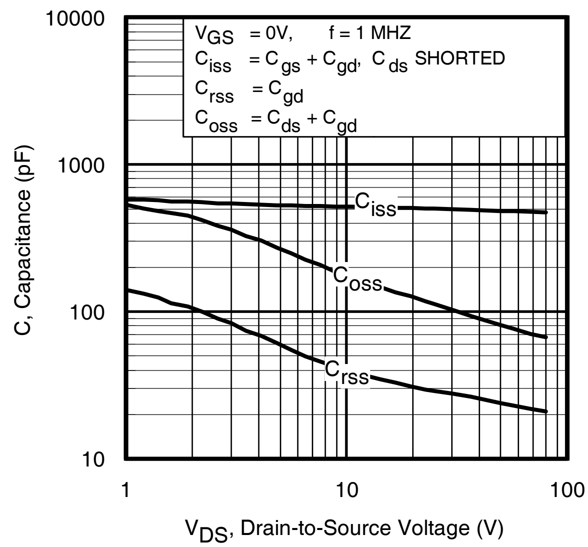


Fig 10. Typical Capacitance vs.Drain-to-Source Voltage

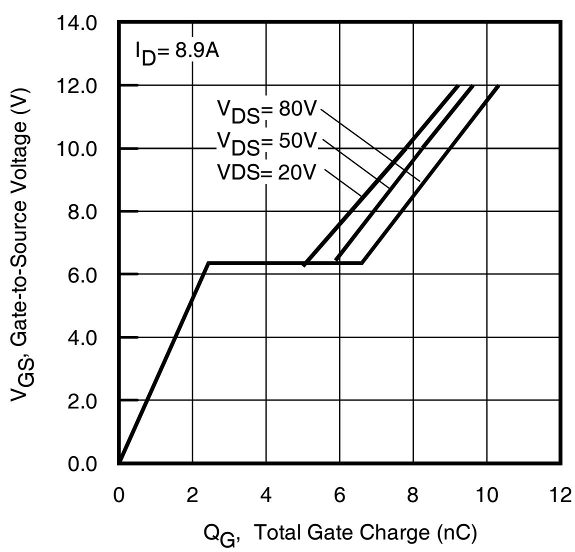


Fig.11 Typical Gate Charge vs.Gate-to-Source Voltage

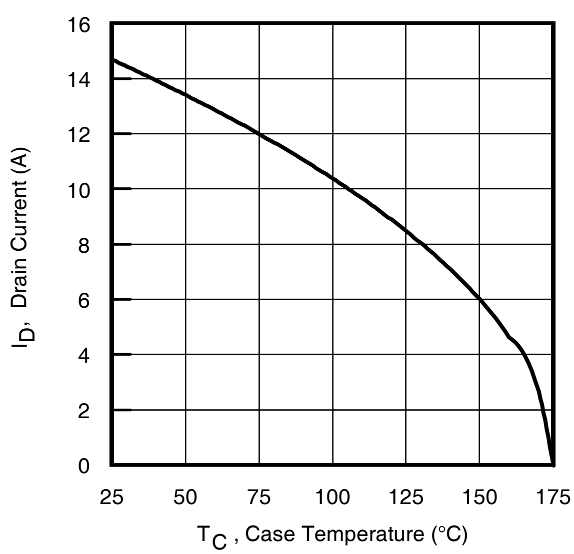


Fig 12. Maximum Drain Current vs. Case Temperature

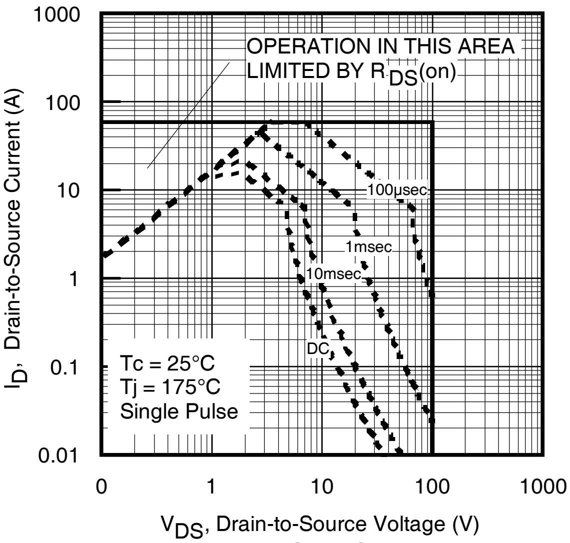


Fig 13. Maximum Safe Operating Area

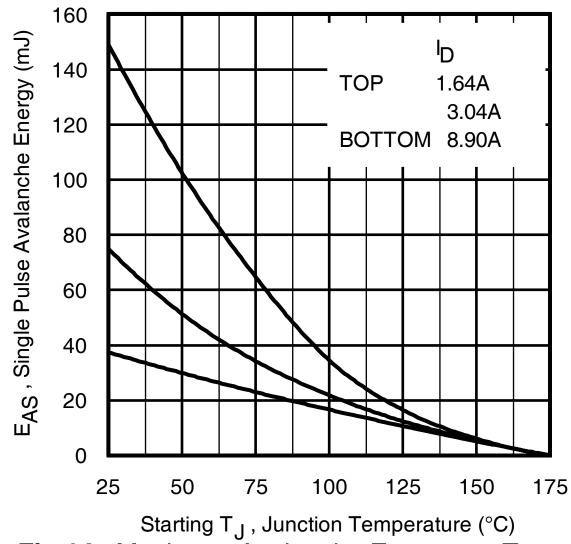


Fig 14. Maximum Avalanche Energy vs. Temperature

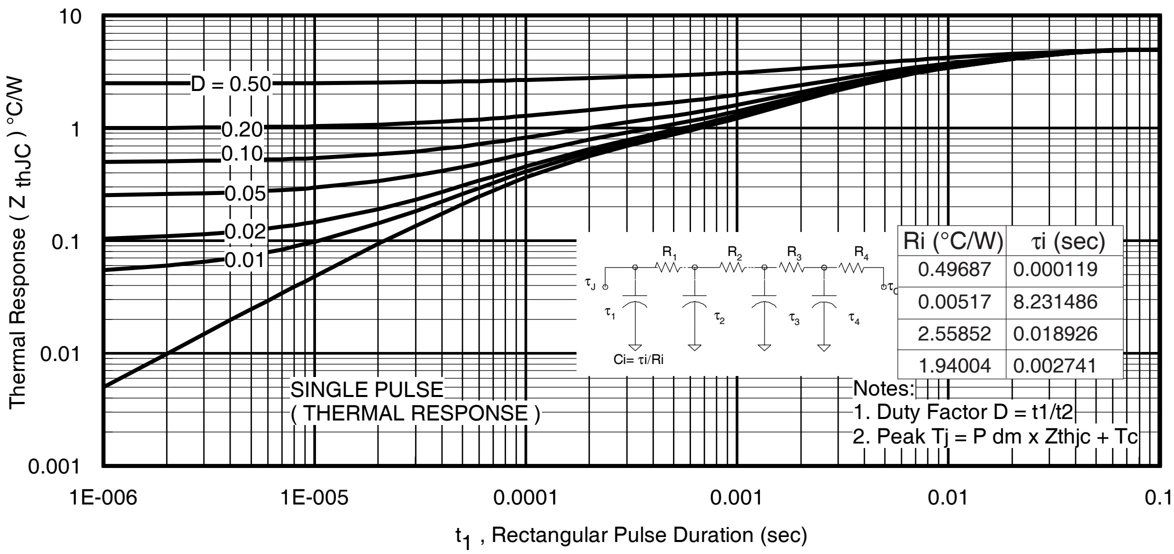


Fig 15. Maximum Effective Transient Thermal Impedance, Junction-to-Case

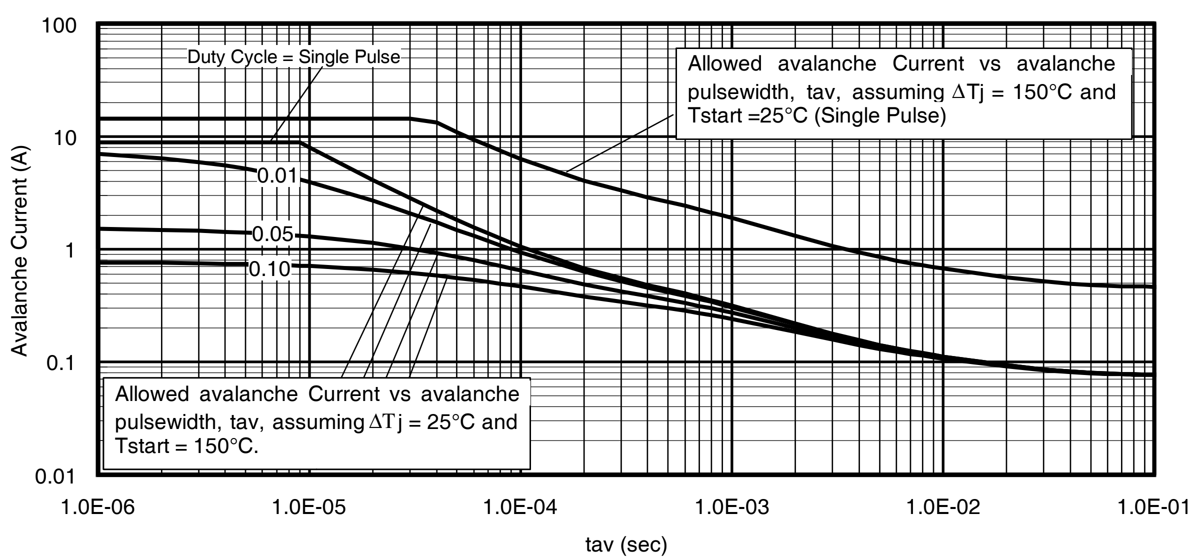


Fig 16. Typical Avalanche Current Vs.Pulsewidth

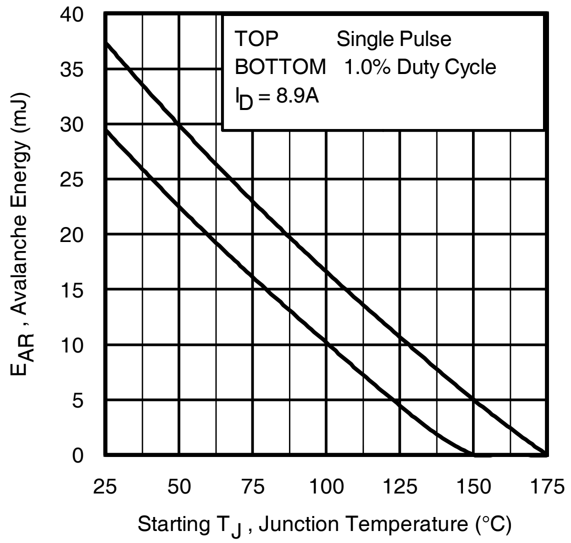


Fig 17. Maximum Avalanche Energy Vs. Temperature

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 figure 11)

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

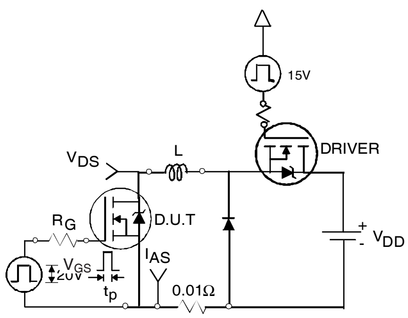


Fig 18a. Unclamped Inductive Test Circuit

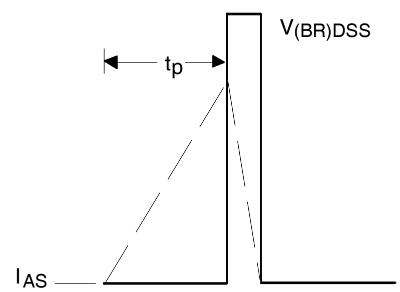


Fig 18b. Unclamped Inductive Waveforms

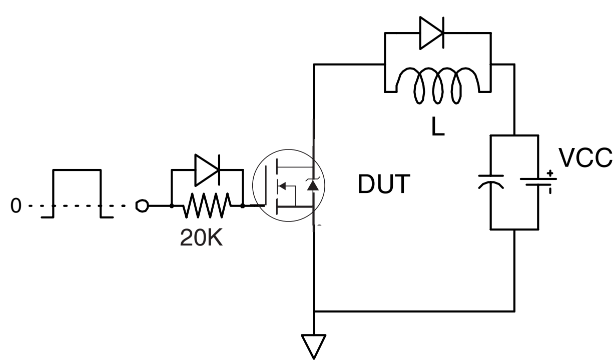


Fig 19a. Gate Charge Test Circuit

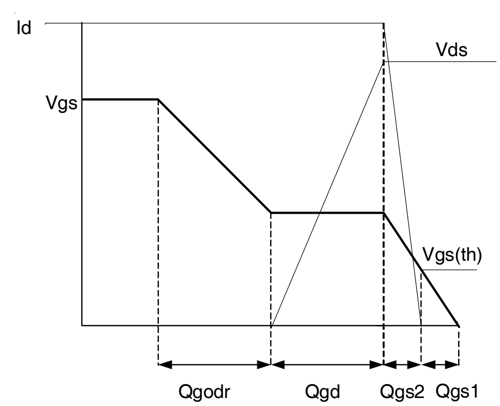


Fig 19b. Gate Charge Waveform

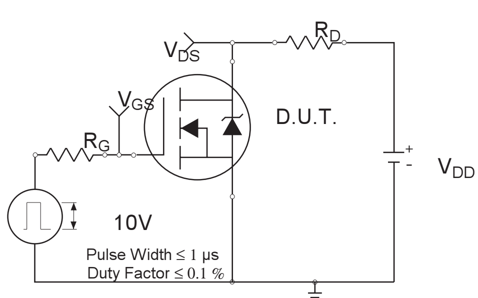


Fig 20a. Switching Time Test Circuit

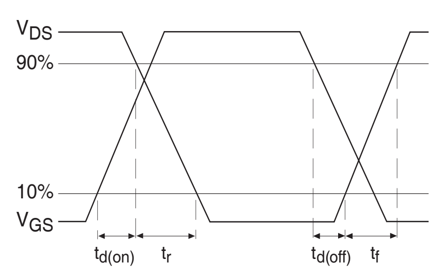
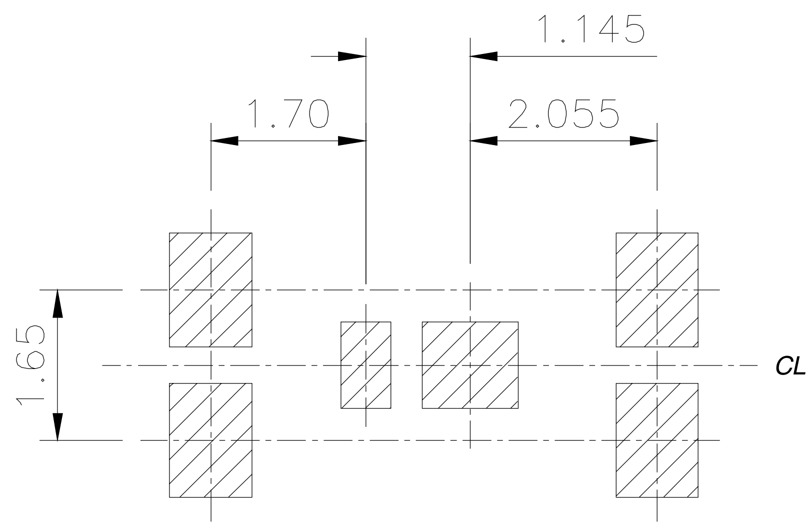
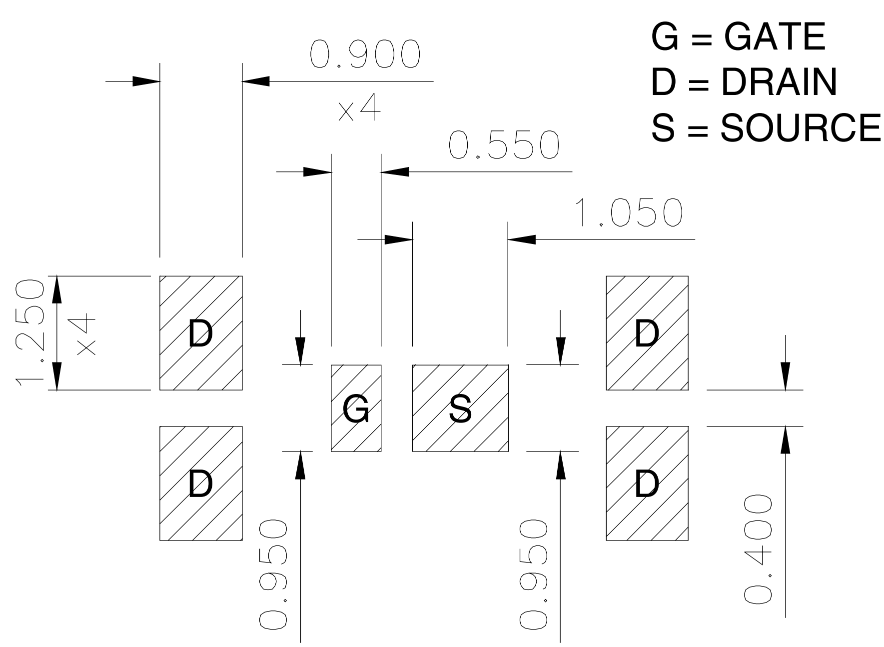


Fig 20b. Switching Time Waveforms

Automotive DirectFET™ Board Footprint, SB (Small Size Can).

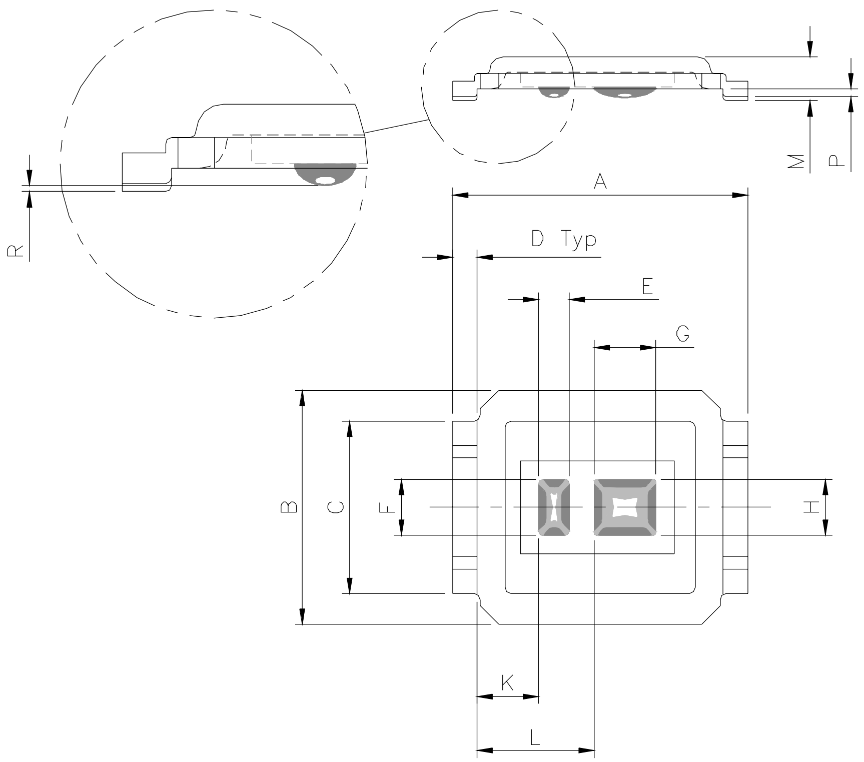
Please see AN-1035 for DirectFET assembly details and stencil and substrate design recommendations





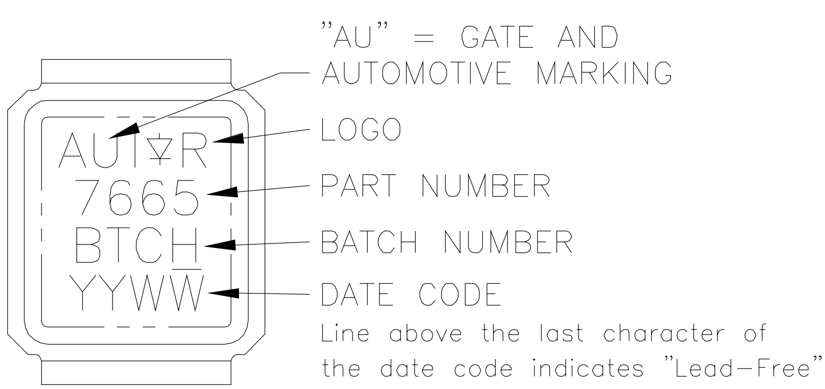
Automotive DirectFET™ Outline Dimension, SB Outline (Small Size Can).

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

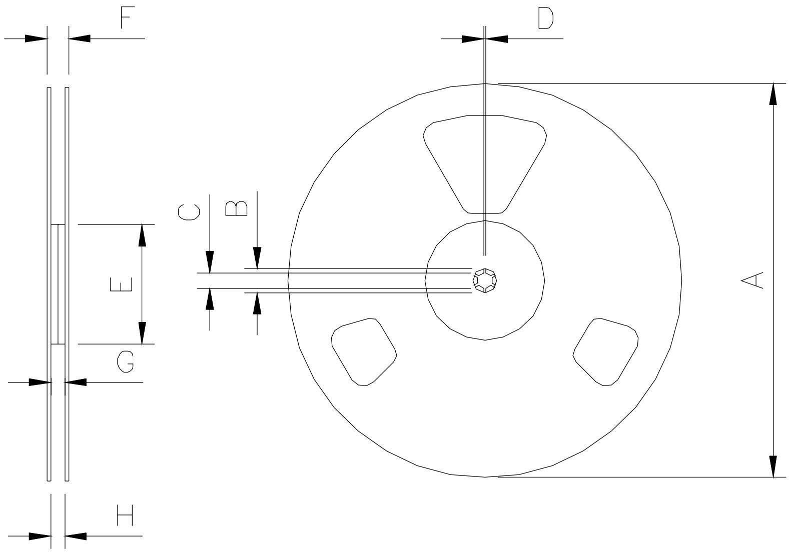


DIMENSIONS				
	METRIC		IMPERIAL	
CODE	MIN	MAX	MIN	MAX
A	4.75	4.85	0.187	0.191
B	3.70	3.95	0.146	0.156
C	2.75	2.85	0.108	0.112
D	0.35	0.45	0.014	0.018
E	0.48	0.52	0.019	0.020
F	0.88	0.92	0.035	0.036
G	0.98	1.02	0.039	0.040
H	0.88	0.92	0.035	0.036
J	N/A	N/A	N/A	N/A
K	0.95	1.05	0.037	0.041
L	1.85	1.95	0.073	0.077
M	0.68	0.74	0.027	0.029
P	0.08	0.17	0.003	0.007
R	0.02	0.08	0.001	0.003

Automotive DirectFET™ Part Marking

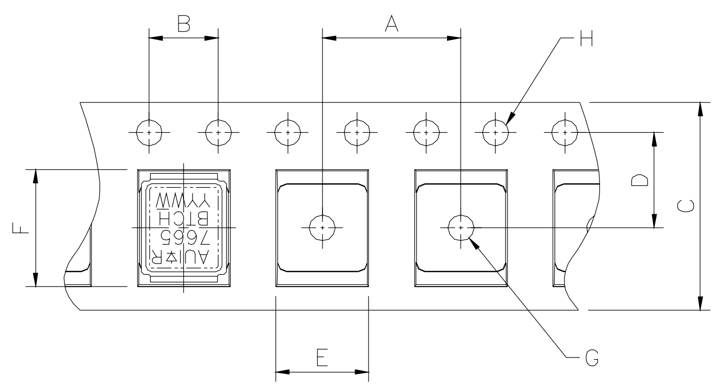


Automotive DirectFET™ Tape & Reel Dimension (Showing component orientation).



NOTE: Controlling dimensions in mm
Std reel quantity is 4800 parts. (ordered as AUIRF7665S2TR). For 1000 parts on 7" reel, order AUIRF7665S2TR1

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



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	4.00	4.20	0.158	0.165
F	5.00	5.20	0.197	0.205
G	1.50	N.C	0.059	N.C
H	1.50	1.60	0.059	0.063

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 $T_J = 25°C$, L = 0.944mH, $R_G = 25\Omega$, $I_{AS} = 8.9A$.
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.

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