

**RADIATION HARDENED  
POWER MOSFET  
THRU-HOLE (Low –Ohmic TO-257AA)**

**250V, N-CHANNEL**  
**REF: MIL-PRF-19500/755**  
**R6 TECHNOLOGY**

**Product Summary**

Part Number	Radiation Level	RDS(on)	I <sub>D</sub>	QPL Part Number
IRHYS67234CM	100K Rads (Si)	0.22Ω	12A	JANSR2N7594T3
IRHYS63234CM	300K Rads (Si)	0.22Ω	12A	JANSF2N7594T3



**Description**

IR HiRel R6 technology provides superior power MOSFETs for space applications. These devices have improved immunity to Single Event Effect (SEE) and have been characterized for useful performance with Linear Energy Transfer (LET) up to 90MeV/(mg/cm<sup>2</sup>). Their combination of very low R<sub>DS(on)</sub> and faster switching times reduces power loss and increases power density in today's high speed switching applications such as DC-DC converters and motor controllers. These devices retain all of the well established advantages of MOSFETs such as voltage control, ease of paralleling and temperature stability of electrical parameters.

**Features**

- Low R<sub>DS(on)</sub>
- Fast Switching
- Single Event Effect (SEE) Hardened
- Low Total Gate Charge
- Simple Drive Requirements
- Hermetically Sealed
- Ceramic Eyelets
- Electrically Isolated
- Light Weight
- ESD Rating: Class 2 per MIL-STD-750, Method 1020

**Absolute Maximum Ratings**

**Pre-Irradiation**

Symbol	Parameter	Value	Units
I <sub>D1</sub> @ V <sub>GS</sub> = 12V, T <sub>C</sub> = 25°C	Continuous Drain Current	12	A
I <sub>D2</sub> @ V <sub>GS</sub> = 12V, T <sub>C</sub> = 100°C	Continuous Drain Current	7.6	
I <sub>DM</sub> @ T <sub>C</sub> = 25°C	Pulsed Drain Current ①	48	
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Maximum Power Dissipation	75	W
	Linear Derating Factor	0.6	W/°C
V <sub>GS</sub>	Gate-to-Source Voltage	± 20	V
E <sub>AS</sub>	Single Pulse Avalanche Energy ②	80	mJ
I <sub>AR</sub>	Avalanche Current ①	12	A
E <sub>AR</sub>	Repetitive Avalanche Energy ①	7.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.2	V/ns
T <sub>J</sub> T <sub>STG</sub>	Operating Junction and Storage Temperature Range	-55 to + 150	°C
	Pckg. Mounting Surface Temp.	300 (0.063 in. / 1.6mm from case for 10s)	
	Weight	4.3 (Typical)	g

For Footnotes, refer to the page 2.

**Electrical Characteristics @ T<sub>J</sub> = 25°C (Unless Otherwise Specified)**

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	250	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	Breakdown Voltage Temp. Coefficient	—	0.26	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.22	Ω	V <sub>GS</sub> = 12V, I <sub>D2</sub> = 7.6A ④
V <sub>GS(th)</sub>	Gate Threshold Voltage	2.0	—	4.0	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1.0mA
ΔV <sub>GS(th)</sub> /ΔT <sub>J</sub>	Gate Threshold Voltage Coefficient	—	-10.2	—	mV/°C	
G <sub>fs</sub>	Forward Transconductance	8.6	—	—	S	V <sub>DS</sub> = 15V, I <sub>D2</sub> = 7.6A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	10	μA	V <sub>DS</sub> = 200V, V <sub>GS</sub> = 0V
		—	—	25		V <sub>DS</sub> = 200V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 125°C
I <sub>GSS</sub>	Gate-to-Source Leakage Forward	—	—	100	nA	V <sub>GS</sub> = 20V
	Gate-to-Source Leakage Reverse	—	—	-100		V <sub>GS</sub> = -20V
Q <sub>G</sub>	Total Gate Charge	—	—	40	nC	I <sub>D1</sub> = 12A
Q <sub>GS</sub>	Gate-to-Source Charge	—	—	12		V <sub>DS</sub> = 125V
Q <sub>GD</sub>	Gate-to-Drain ('Miller') Charge	—	—	17		V <sub>GS</sub> = 12V
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	19	ns	V <sub>DD</sub> = 125V
t <sub>r</sub>	Rise Time	—	—	27		I <sub>D1</sub> = 12A
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	36		R <sub>G</sub> = 7.5Ω
t <sub>f</sub>	Fall Time	—	—	20		V <sub>GS</sub> = 12V
L <sub>S</sub> + L <sub>D</sub>	Total Inductance	—	6.8	—	nH	Measured from Drain lead( 6mm / 0.25 in from package )to Source lead ( 6mm/ 0.25 in from package )
C <sub>iss</sub>	Input Capacitance	—	1420	—	pF	V <sub>GS</sub> = 0V
C <sub>oss</sub>	Output Capacitance	—	184	—		V <sub>DS</sub> = 25V
C <sub>rss</sub>	Reverse Transfer Capacitance	—	2.2	—		f = 1.0MHz
R <sub>G</sub>	Gate Resistance	—	9.8	—	Ω	f = 1.0MHz, open drain

**Source-Drain Diode Ratings and Characteristics**

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	12	A	
I <sub>SM</sub>	Pulsed Source Current (Body Diode) ①	—	—	48		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.2	V	T <sub>J</sub> = 25°C, I <sub>S</sub> = 12A, V <sub>GS</sub> = 0V④
t <sub>rr</sub>	Reverse Recovery Time	—	281	450	ns	T <sub>J</sub> = 25°C, I <sub>F</sub> = 12A, V <sub>DD</sub> ≤ 50V
Q <sub>rr</sub>	Reverse Recovery Charge	—	—	5.0	μC	di/dt = 100A/μs ④
t <sub>on</sub>	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> +L <sub>D</sub> )				

**Thermal Resistance**

Symbol	Parameter	Min.	Typ.	Max.	Units
R <sub>θJC</sub>	Junction-to-Case	—	—	1.67	°C/W
R <sub>θJA</sub>	Junction-to-Ambient (Typical Socket Mount)	—	—	80	

**Footnotes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ② V<sub>DD</sub> = 50V, starting T<sub>J</sub> = 25°C, L = 1.1mH, Peak I<sub>L</sub> = 12A, V<sub>GS</sub> = 12V
- ③ I<sub>SD</sub> ≤ 12A, di/dt ≤ 508A/μs, V<sub>DD</sub> ≤ 250V, T<sub>J</sub> ≤ 150°C
- ④ Pulse width ≤ 300 μs; Duty Cycle ≤ 2%
- ⑤ Total Dose Irradiation with V<sub>GS</sub> Bias. 12 volt V<sub>GS</sub> applied and V<sub>DS</sub> = 0 during irradiation per MIL-STD-750, Method 1019, condition A.
- ⑥ Total Dose Irradiation with V<sub>DS</sub> Bias. 200 volt V<sub>DS</sub> applied and V<sub>GS</sub> = 0 during irradiation per MIL-STD-750, Method 1019, condition A.

## Radiation Characteristics

IR HiRel Radiation Hardened MOSFETs are tested to verify their radiation hardness capability. The hardness assurance program at IR HiRel is comprised of two radiation environments. Every manufacturing lot is tested for total ionizing dose (per notes 5 and 6) using the TO-3 package. Both pre- and post-irradiation performance are tested and specified using the same drive circuitry and test conditions in order to provide a direct comparison.

**Table1. Electrical Characteristics @ Tj = 25°C, Post Total Dose Irradiation ⑤⑥**

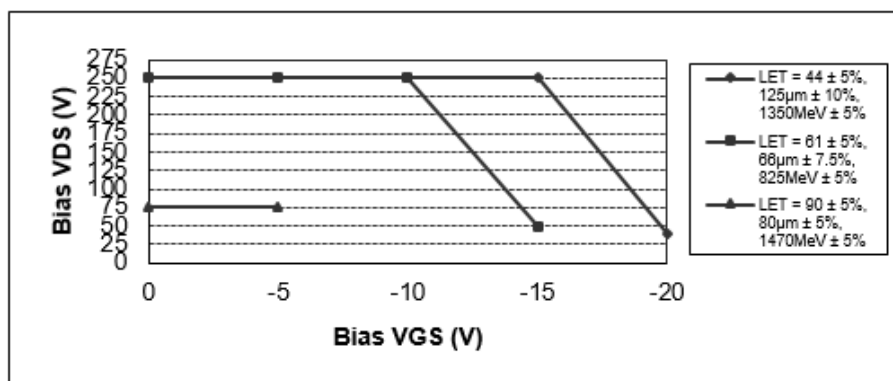
Symbol	Parameter	Up to 300 kRads (Si) <sup>1</sup>		Units	Test Conditions
		Min.	Max.		
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	250	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
V <sub>GS(th)</sub>	Gate Threshold Voltage	2.0	4.0	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1.0mA
I <sub>GSS</sub>	Gate-to-Source Leakage Forward	—	100	nA	V <sub>GS</sub> = 20V
I <sub>GSS</sub>	Gate-to-Source Leakage Reverse	—	-100	nA	V <sub>GS</sub> = -20V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	10	μA	V <sub>DS</sub> = 200V, V <sub>GS</sub> = 0V
R <sub>DS(on)</sub>	Static Drain-to-Source <sup>④</sup> On-State Resistance (TO-3)	—	0.24	Ω	V <sub>GS</sub> = 12V, I <sub>D2</sub> = 7.6A
R <sub>DS(on)</sub>	Static Drain-to-Source <sup>④</sup> On-State Resistance (TO-257AA)	—	0.22	Ω	V <sub>GS</sub> = 12V, I <sub>D2</sub> = 7.6A
V <sub>SD</sub>	Diode Forward Voltage <sup>④</sup>	—	1.2	V	V <sub>GS</sub> = 0V, I <sub>S</sub> = 12A

<sup>1</sup> Part numbers IRHYS67234CM (JANSR2N7594T3) and IRHYS63234CM (JANSF2N7594T3)

IR HiRel radiation hardened MOSFETs have been characterized in heavy ion environment for Single Event Effects (SEE). Single Event Effects characterization is illustrated in Fig. a and Table 2.

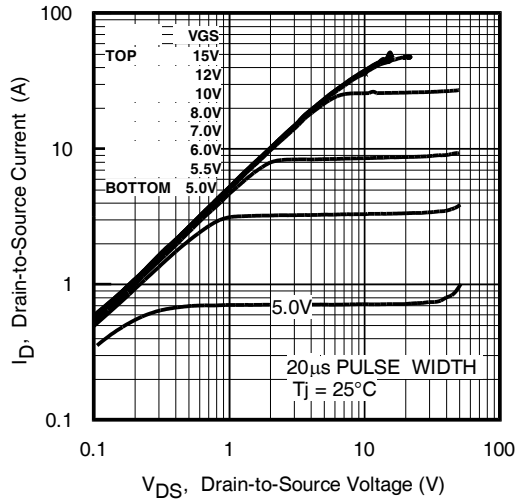
**Table 2. Typical Single Event Effect Safe Operating Area**

LET (MeV/(mg/cm <sup>2</sup> ))	Energy (MeV)	Range (μm)	V <sub>DS</sub> (V)				
			@V <sub>GS</sub> = 0V	@V <sub>GS</sub> = -5V	@V <sub>GS</sub> = -10V	@V <sub>GS</sub> = -15V	@V <sub>GS</sub> = -20V
44 ± 5%	1350 ± 5%	125 ± 5%	250	250	250	250	40
61 ± 5%	825 ± 5%	66 ± 5%	250	250	250	50	—
90 ± 5%	1470 ± 5%	80 ± 5%	75	75	—	—	—

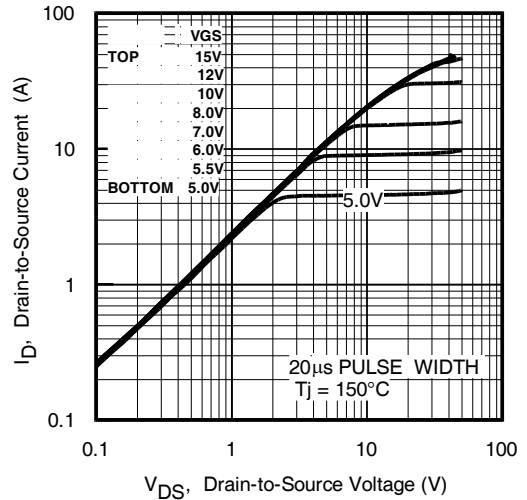


**Fig a.** Typical Single Event Effect, Safe Operating Area

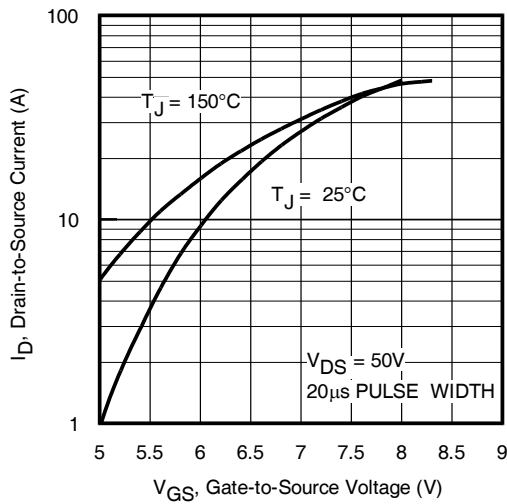
For Footnotes, refer to the page 2.



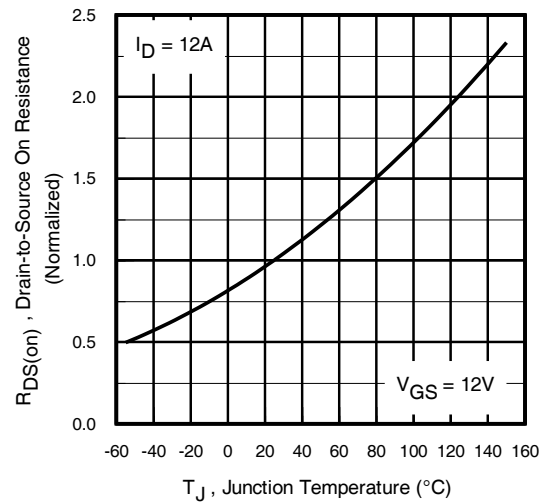
**Fig 1. Typical Output Characteristics**



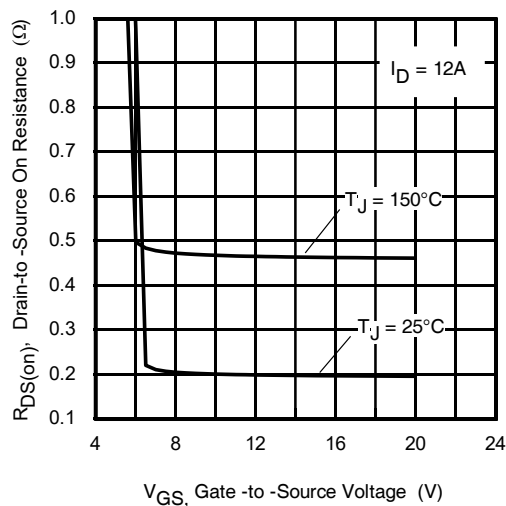
**Fig 2. Typical Output Characteristics**



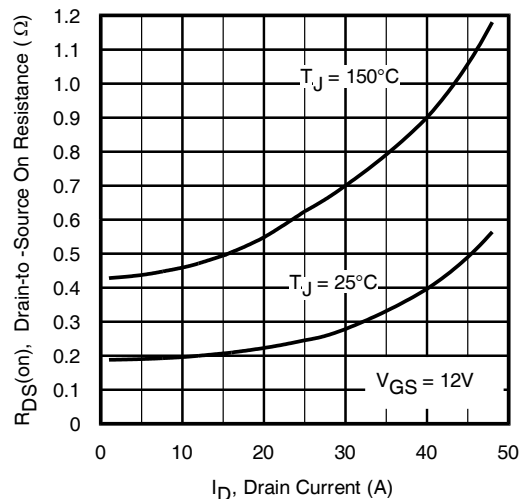
**Fig 3. Typical Transfer Characteristics**



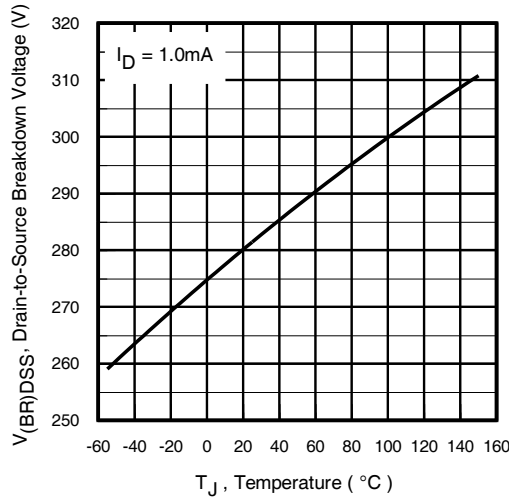
**Fig 4. Normalized On-Resistance Vs. Temperature**



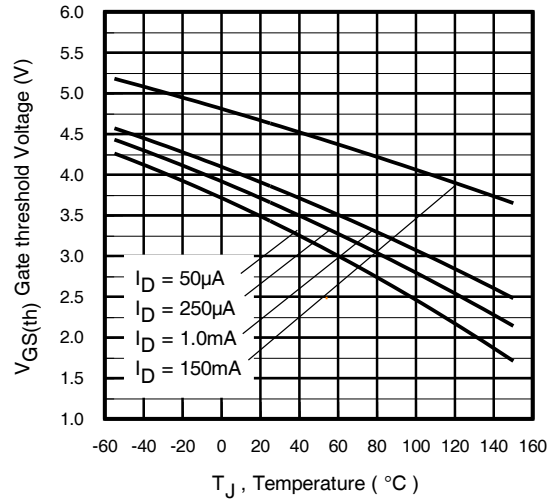
**Fig 5. Typical On-Resistance Vs Gate Voltage**



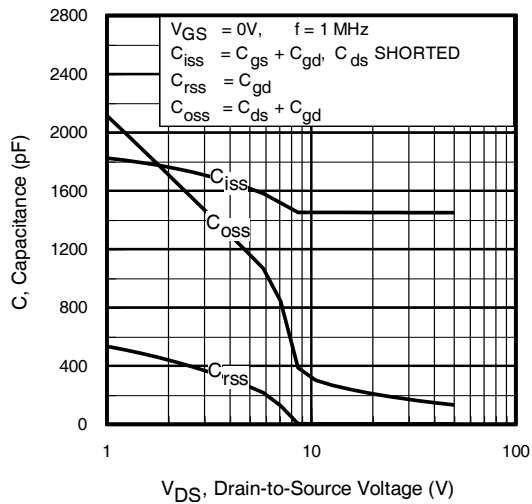
**Fig 6. Typical On-Resistance Vs Drain Current**



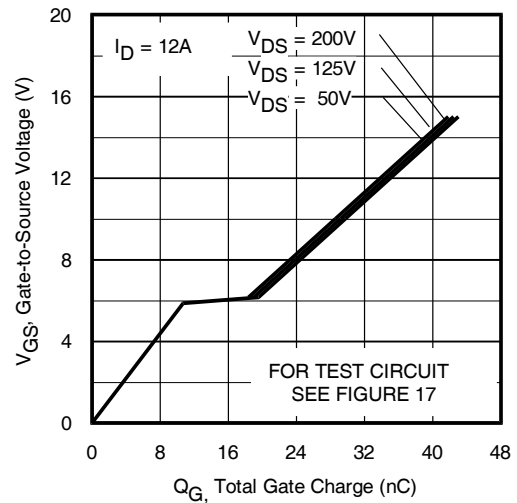
**Fig 7.** Typical Drain-to-Source Breakdown Voltage Vs Temperature



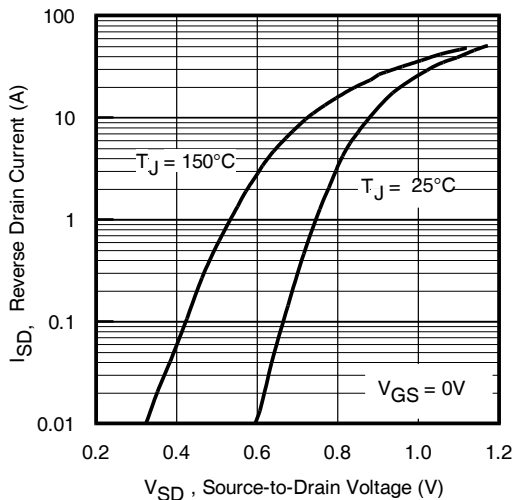
**Fig 8.** Typical Threshold Voltage Vs Temperature



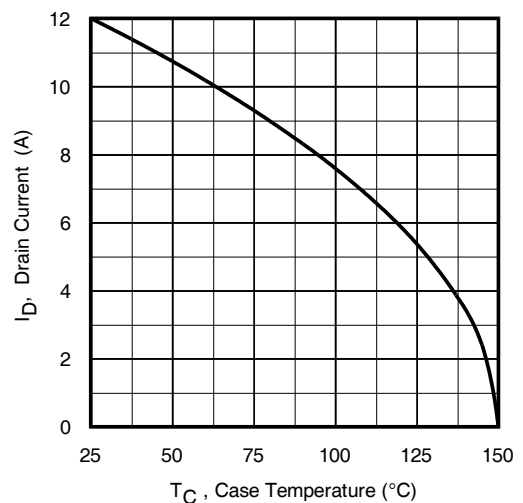
**Fig 9.** Typical Capacitance Vs. Drain-to-Source Voltage



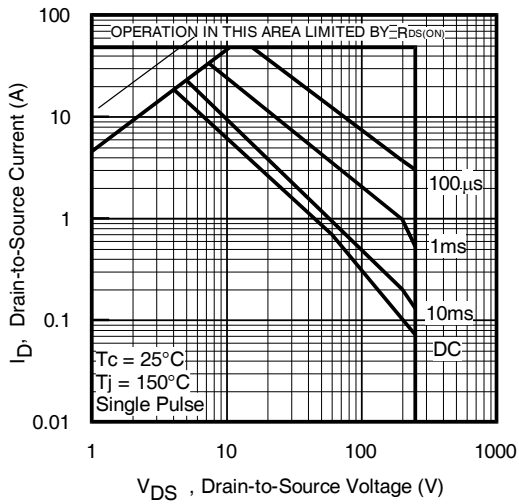
**Fig 10.** Typical Gate Charge Vs. Gate-to-Source Voltage



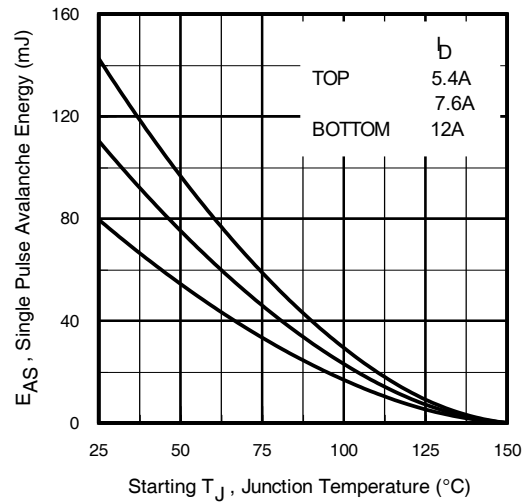
**Fig 11.** Typical Source-to-Drain Diode Forward Voltage



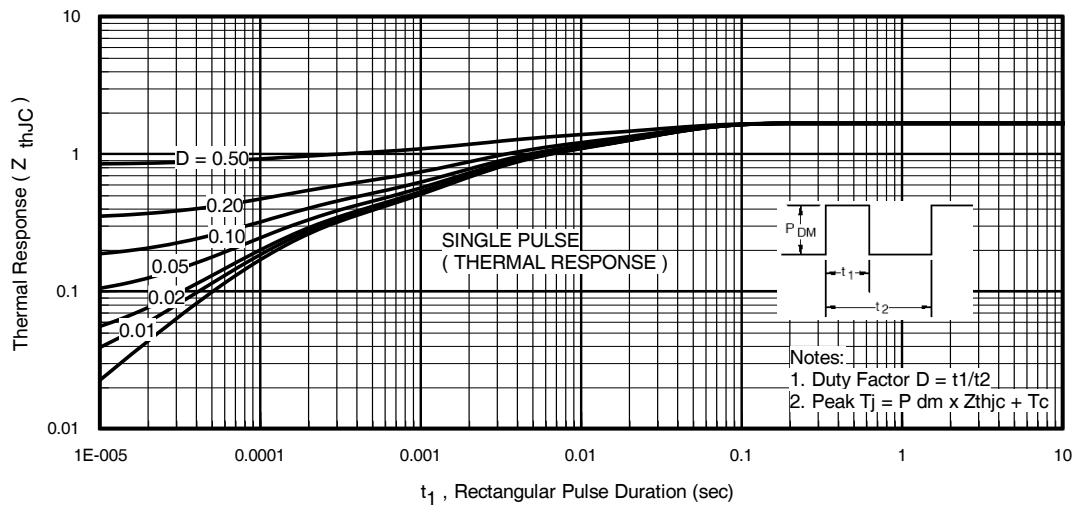
**Fig 12.** Maximum Drain Current Vs. Case Temperature



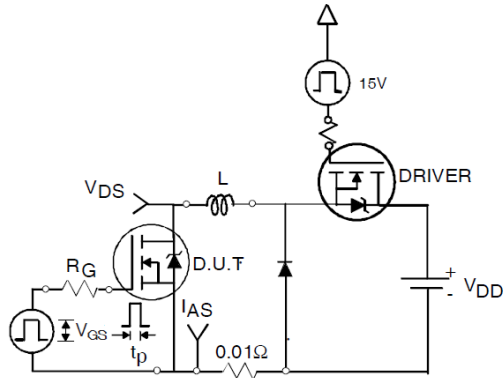
**Fig 13.** Maximum Safe Operating Area



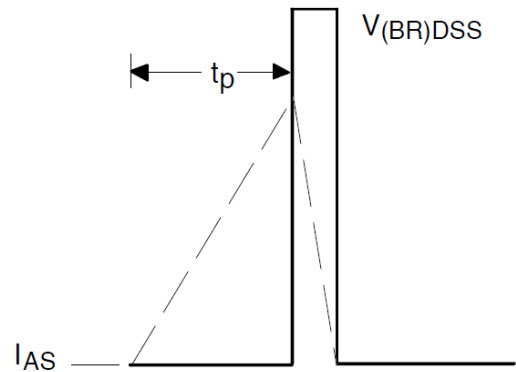
**Fig 14.** Maximum Avalanche Energy Vs. Drain Current



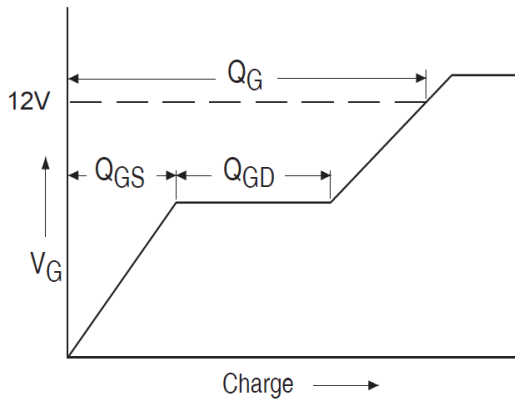
**Fig 15.** Maximum Effective Transient Thermal Impedance, Junction-to-



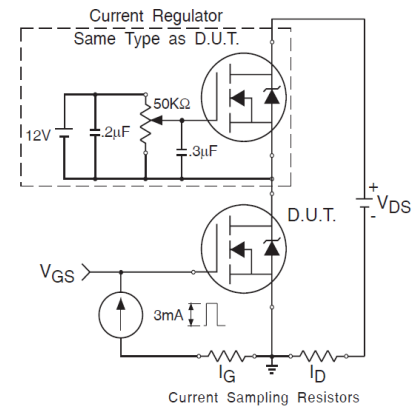
**Fig 16a.** Unclamped Inductive Test Circuit



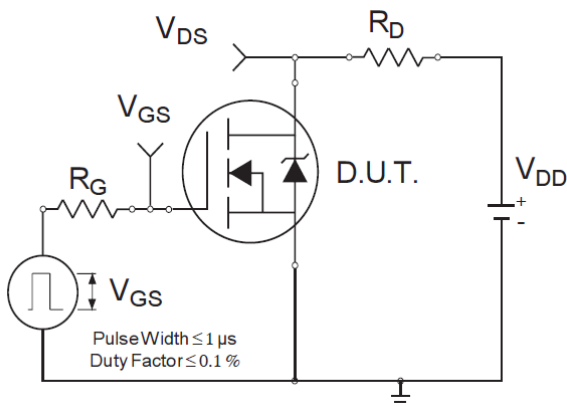
**Fig 16b.** Unclamped Inductive Wave-



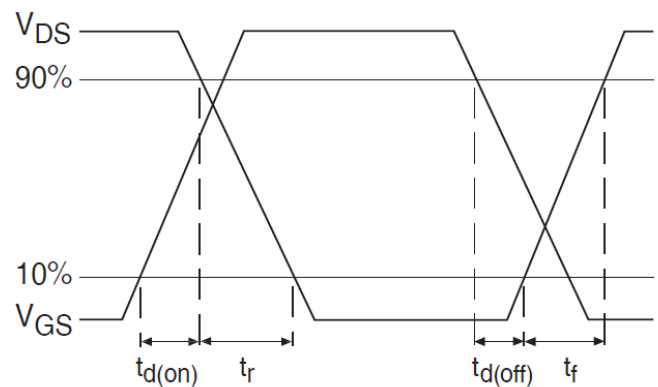
**Fig 17a.** Basic Gate Charge Waveform



**Fig 17b.** Gate Charge Test Circuit



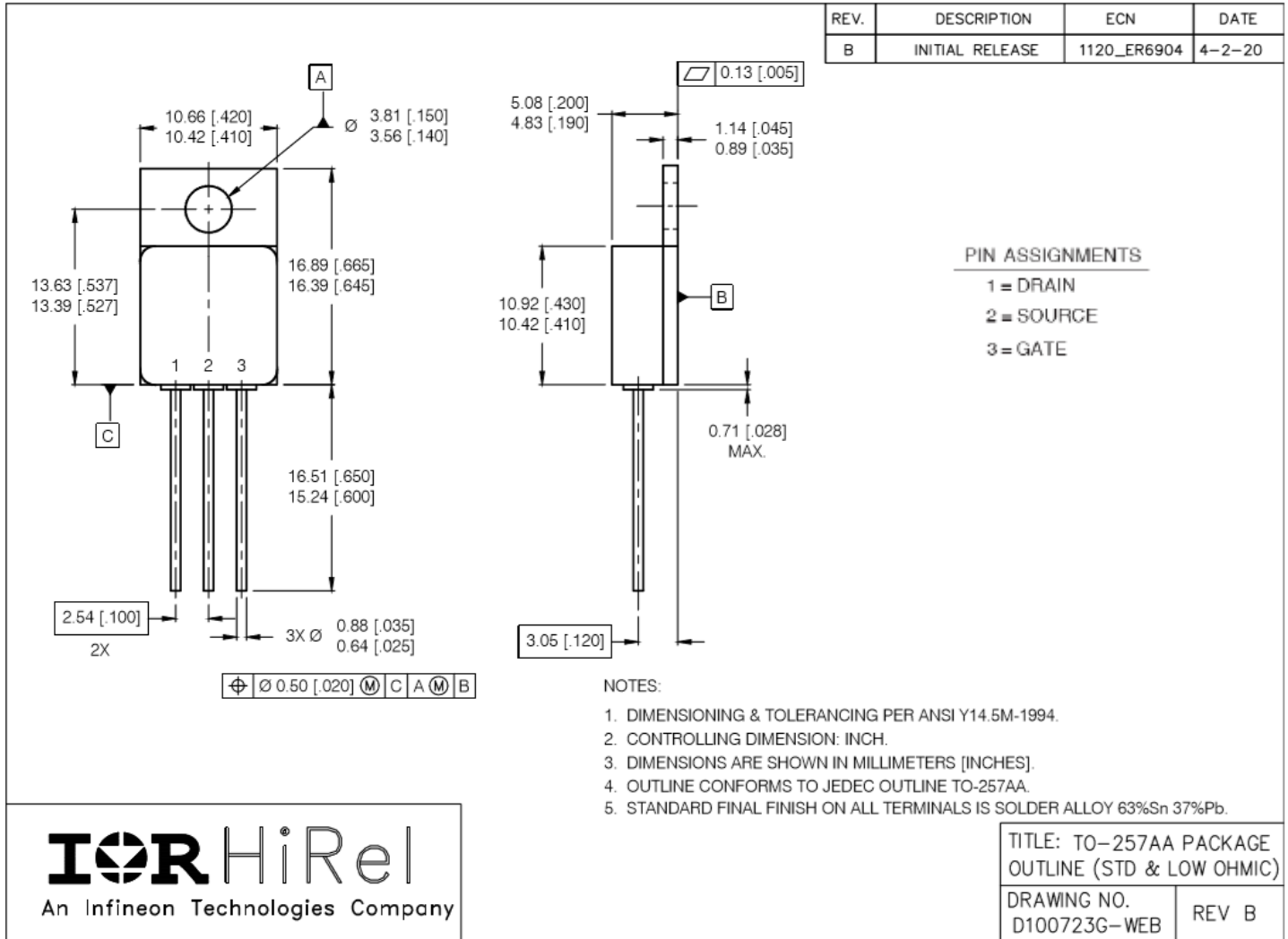
**Fig 18a.** Switching Time Test Circuit



**Fig 18b.** Switching Time Waveforms

Note: For the most updated package outline, please see the website: [TO-257AA](http://TO-257AA)

**Case Outline and Dimensions — Low -Ohmic (TO-257AA)**



**BERYLLIA WARNING PER MIL-PRF-19500**

Package containing beryllia shall not be ground, sandblasted, machined, or have other operations performed on them which will produce beryllia or beryllium dust. Furthermore, beryllium oxide packages shall not be placed in acids that will produce fumes containing beryllium.



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