

IRHY9230CM

PD-91401A

Radiation Hardened Power MOSFET Thru-Hole (TO-257AA) 200V, P-channel, Rad Hard HEXFET™ Technology

Features

- Single event effect (SEE) hardened
- Low $R_{DS(on)}$
- Low total gate charge
- Proton tolerant
- Simple drive requirements
- Hermetically sealed
- Ceramic package
- Light weight

Potential Applications

- DC-DC converter
- Motor drives
- Solid state relays

Product Validation

Qualified to IR HiRel's S-level screening flow which is equivalent to MIL-PRF-19500

Description

IR HiRel rad hard HEXFET technology provides high performance power MOSFETs for space applications. This technology has over a decade of proven performance and reliability in satellite applications. These devices have been characterized for both Total Dose and Single Event Effects (SEE). The combination of low $R_{DS(on)}$ and low gate charge reduces the power losses in switching applications such as DC to DC converters and motor control. These devices retain all of the well established advantages of MOSFETs such as voltage control, fast switching and temperature stability of electrical parameters.

Ordering Information

Table 1 **Ordering options**

Part number	Package	Screening Level	TID Level
IRHY9230CM	TO-257AA	COTS	100krad(Si)
IRHY9230CMSCS	TO-257AA	S-Level	100krad(Si)
IRHY9230CMSCSA	TO-257AA with Lead Form Down	S-Level	100krad(Si)

Product Summary

Part number: IRHY9230CM

Radiation level: 100 krad(Si)

$R_{DS(on),max}$: 0.8Ω

I_D : -6.5A

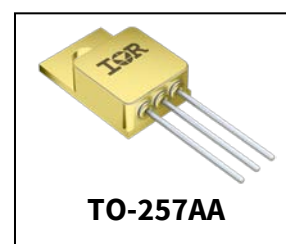


Table of contents

Table of contents

Features	1
Potential Applications.....	1
Product Validation.....	1
Description	1
Ordering Information.....	1
Table of contents.....	2
1 Absolute Maximum Ratings	3
2 Device Characteristics	4
2.1 Electrical Characteristics (Pre-Irradiation).....	4
2.2 Source-Drain Diode Ratings and Characteristics (Pre-Irradiation)	5
2.3 Thermal Characteristics	5
2.4 Radiation Characteristics.....	5
2.4.1 Electrical Characteristics - Post Total Dose Irradiation	5
2.4.2 Single Event Effects – Safe Operating Area	6
3 Electrical Characteristics Curves (Pre-irradiation)	7
4 Test Circuits (Pre-irradiation)	10
5 Package Outline.....	11
Revision history.....	12

Absolute Maximum Ratings

1 Absolute Maximum Ratings

Table 2 Absolute Maximum Ratings (Pre-Irradiation)

Symbol	Parameter	Value	Unit
$I_{D1} @ V_{GS} = 12V, T_C = 25^{\circ}C$	Continuous Drain Current	-6.5	A
$I_{D2} @ V_{GS} = 12V, T_C = 100^{\circ}C$	Continuous Drain Current	-4.1	A
$I_{DM} @ T_C = 25^{\circ}C$	Pulsed Drain Current ¹	-26	A
$P_D @ T_C = 25^{\circ}C$	Maximum Power Dissipation	75	W
	Linear Derating Factor	0.6	W/ $^{\circ}C$
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy ²	165	mJ
I_{AR}	Avalanche Current ¹	-6.5	A
E_{AR}	Repetitive Avalanche Energy ¹	7.5	mJ
dv/dt	Peak Diode Reverse Recovery ³	-27	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	$^{\circ}C$
	Lead Temperature	300 (0.063in./1.6mm from case for 10s)	
	Weight	4.3 (Typical)	

¹ Repetitive Rating; Pulse width limited by maximum junction temperature.² $V_{DD} = -50V$, starting $T_J = 25^{\circ}C$, $L = 11mH$, Peak $I_L = -6.5A$, $V_{GS} = -12V$ ³ $I_{SD} \leq -6.5A$, $di/dt \leq -375A/\mu s$, $V_{DD} \leq -200V$, $T_J \leq 150^{\circ}C$

Device Characteristics

2 Device Characteristics

2.1 Electrical Characteristics (Pre-Irradiation)

Table 3 Static and Dynamic Electrical Characteristics @ $T_j = 25^\circ\text{C}$ (Unless Otherwise Specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-200	—	—	V	$V_{GS} = 0V, I_D = -1.0mA$
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	-0.27	—	V/ $^\circ\text{C}$	Reference to 25°C , $I_D = -1.0mA$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	0.8	Ω	$V_{GS} = -12V, I_{D2} = -4.1A^1$
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	—	-4.0	V	$V_{DS} = V_{GS}, I_D = -1mA$
G_{fs}	Forward Transconductance	2.0	—	—	S	$V_{DS} = -15V, I_{D2} = -4.1A^1$
I_{DSS}	Zero Gate Voltage Drain Current	—	—	-25	μA	$V_{DS} = -160V, V_{GS} = 0V$
		—	—	-250		$V_{DS} = -160V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
I_{GSS}	Gate-to-Source Leakage Forward	—	—	-100	nA	$V_{GS} = -20V$
	Gate-to-Source Leakage Reverse	—	—	100		$V_{GS} = 20V$
Q_G	Total Gate Charge	—	—	45	nC	$I_{D1} = -6.5A$
Q_{GS}	Gate-to-Source Charge	—	—	10		$V_{DS} = -100V$
Q_{GD}	Gate-to-Drain ('Miller') Charge	—	—	25		$V_{GS} = -12V$
$t_{d(on)}$	Turn-On Delay Time	—	—	30	ns	$I_{D1} = -6.5A^{**}$ $V_{DD} = -100V$ $R_G = 7.5\Omega$ $V_{GS} = -12V$
t_r	Rise Time	—	—	50		
$t_{d(off)}$	Turn-Off Delay Time	—	—	75		
t_f	Fall Time	—	—	65		
$L_s + L_D$	Total Inductance	—	6.8	—	nH	Measured from Drain lead (6mm /0.25in. from package) to Source lead (6mm /0.25in. From package) with Source wires internally bonded from Source Pin to Drain Pad
C_{iss}	Input Capacitance	—	1360	—	pF	$V_{GS} = 0V$
C_{oss}	Output Capacitance	—	190	—		$V_{DS} = -25V$
C_{rss}	Reverse Transfer Capacitance	—	40	—		$f = 1.0MHz$

** Switching speed maximum limits are based on manufacturing test equipment and capability.

¹ Pulse width $\leq 300 \mu s$; Duty Cycle $\leq 2\%$

Device Characteristics

2.2 Source-Drain Diode Ratings and Characteristics (Pre-Irradiation)

Table 4 Source-Drain Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
I _S	Continuous Source Current (Body Diode)	—	—	-6.5	A	
I _{SM}	Pulsed Source Current (Body Diode) ¹	—	—	-26	A	
V _{SD}	Diode Forward Voltage	—	—	-5.0	V	T _J = 25°C, I _S = -6.5A, V _{GS} = 0V ²
t _{rr}	Reverse Recovery Time	—	—	400	ns	T _J = 25°C, I _F = -6.5A, V _{DD} ≤ -25V di/dt = -100A/μs ²
Q _{rr}	Reverse Recovery Charge	—	—	3.4	μC	
t _{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L _S +L _D)				

2.3 Thermal Characteristics

Table 5 Thermal Resistance

Symbol	Parameter	Min.	Typ.	Max.	Unit
$R_{\theta JC}$	Junction-to-Case	—	—	1.67	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Junction-to-Ambient	—	—	80	

2.4 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 3 and 4) 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.

2.4.1 Electrical Characteristics - Post Total Dose Irradiation

Table 6 Electrical Characteristics @ $T_J = 25^\circ\text{C}$, Post Total Dose Irradiation ^{3, 4}

Symbol	Parameter	Upto 100krads (Si)		Unit	Test Conditions
		Min.	Max.		
BV_{DSS}	Drain-to-Source Breakdown Voltage	-200	—	V	$V_{GS} = 0\text{V}$, $I_D = -1\text{mA}$
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	-4.0	V	$V_{DS} = V_{GS}$, $I_D = -1\text{mA}$
I_{GSS}	Gate-to-Source Leakage Forward	—	-100	nA	$V_{GS} = -20\text{V}$
	Gate-to-Source Leakage Reverse	—	100		$V_{GS} = 20\text{V}$
I_{DSS}	Zero Gate Voltage Drain Current	—	-25	μA	$V_{DS} = -160\text{V}$, $V_{GS} = 0\text{V}$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-3) ²	—	0.804	Ω	$V_{GS} = -12\text{V}$, $I_{D2} = -4.1\text{A}$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-257AA) ²	—	0.8	Ω	$V_{GS} = -12\text{V}$, $I_{D2} = -4.1\text{A}$
V_{SD}	Diode Forward Voltage	—	-5.0	V	$V_{GS} = 0\text{V}$, $I_F = -6.5\text{A}$

¹ Repetitive Rating; Pulse width limited by maximum junction temperature.

² Pulse width $\leq 300\text{ }\mu\text{s}$; Duty Cycle $\leq 2\%$

³ Total Dose Irradiation with V_{GS} Bias. $V_{GS} = -12\text{V}$ applied and $V_{DS} = 0$ during irradiation per MIL-STD-750, Method 1019, condition A.

⁴ Total Dose Irradiation with V_{DS} Bias. $V_{DS} = -160\text{V}$ applied and $V_{GS} = 0$ during irradiation per MIL-STD-750, Method 1019, condition A.

IRHY9230CM

Radiation Hardened Power MOSFET THRU-HOLE (TO-257AA)

Device Characteristics

2.4.2 Single Event Effects – Safe Operating Area

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. 1 and Table 7.

Table 7 Typical Single Event Effects Safe Operating Area

Ion	LET (MeV/(mg/cm ²))	Energy (MeV)	Range (μm)	V _{DS} (V)				
				V _{GS} = 0V	V _{GS} = 5V	V _{GS} = 10V	V _{GS} = 15V	V _{GS} = 20V
Cu	28	285	43	-200	-200	-200	-200	—
Br	36.8	305	39	-200	-200	-125	-75	—

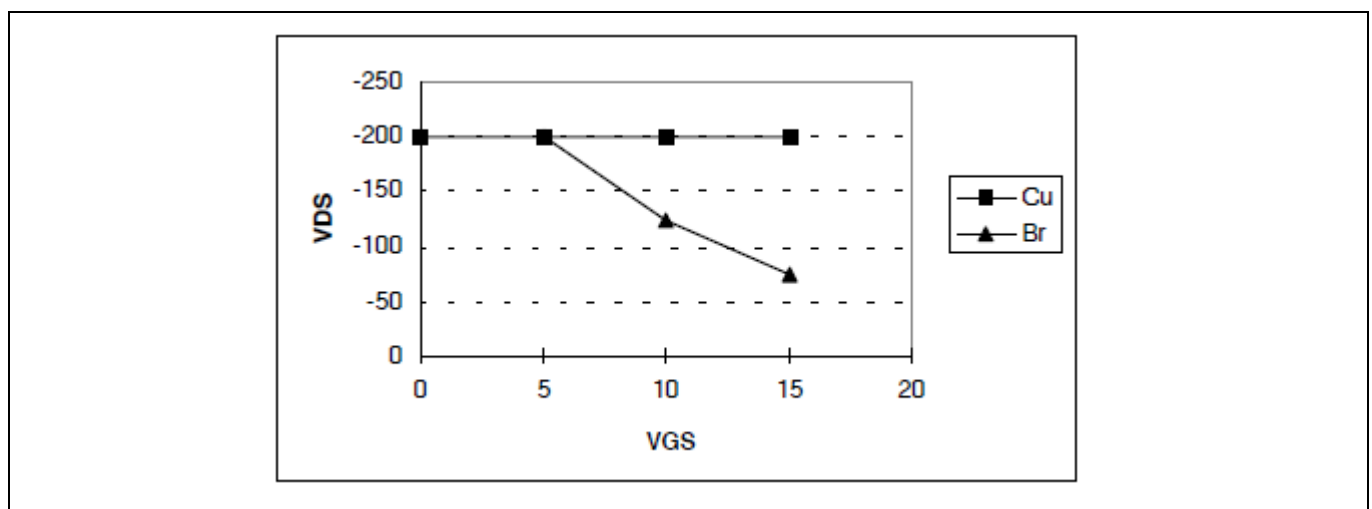


Figure 1 Typical Single Event Effect, Safe Operating Area

IRHY9230CM

Radiation Hardened Power MOSFET THRU-HOLE (TO-257AA)

Electrical Characteristics Curves (Pre-irradiation)

3 Electrical Characteristics Curves (Pre-irradiation)

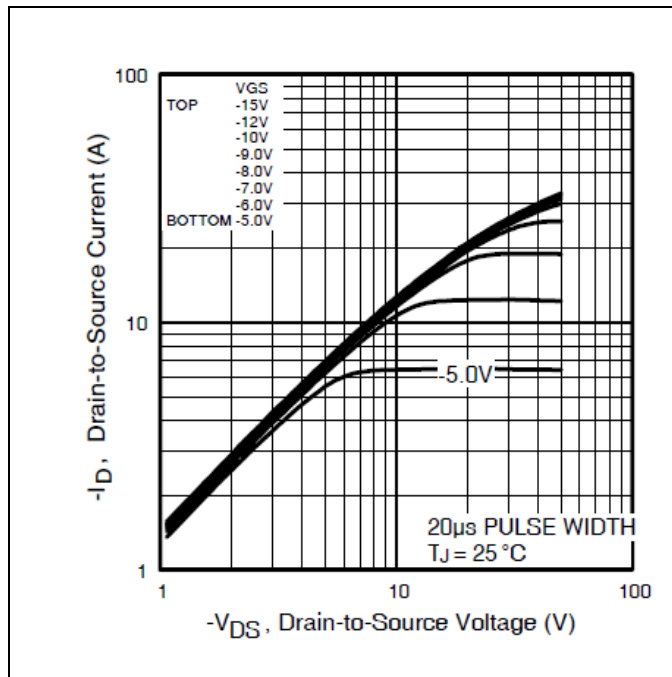


Figure 2 Typical Output Characteristics

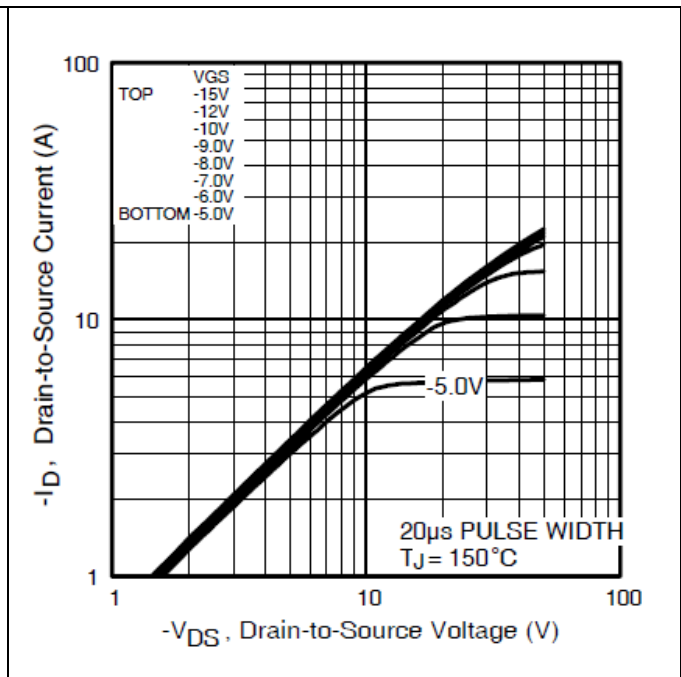


Figure 3 Typical Output Characteristics

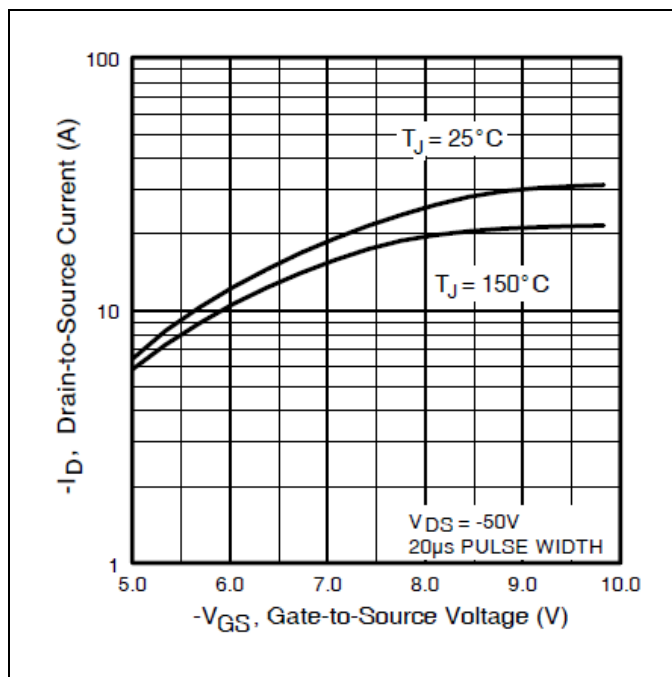


Figure 4 Typical Transfer Characteristics

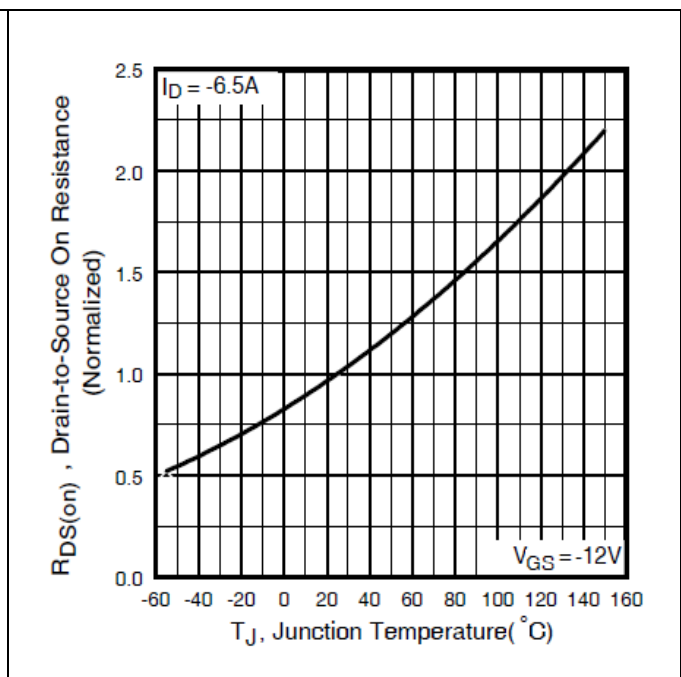


Figure 5 Normalized On-Resistance Vs. Temperature

Radiation Hardened Power MOSFET THRU-HOLE (TO-257AA)

Electrical Characteristics Curves (Pre-irradiation)

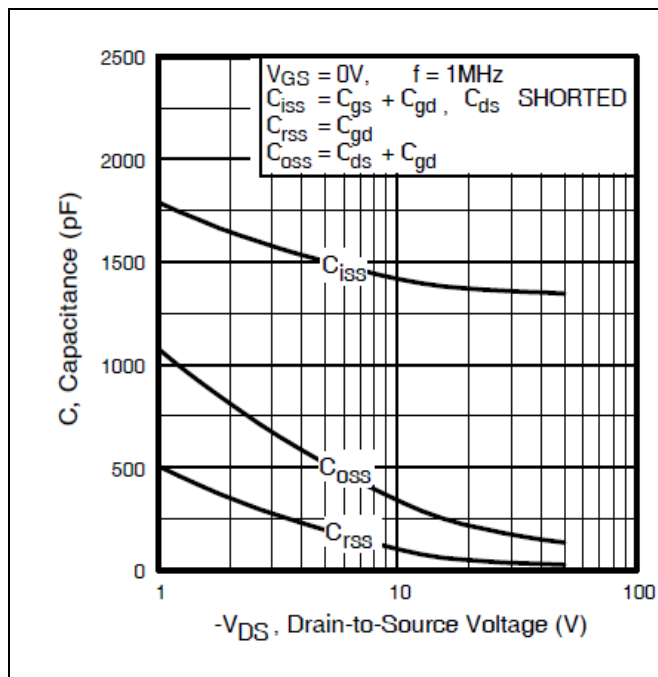


Figure 6 Typical Capacitance Vs. Drain-to-Source Voltage

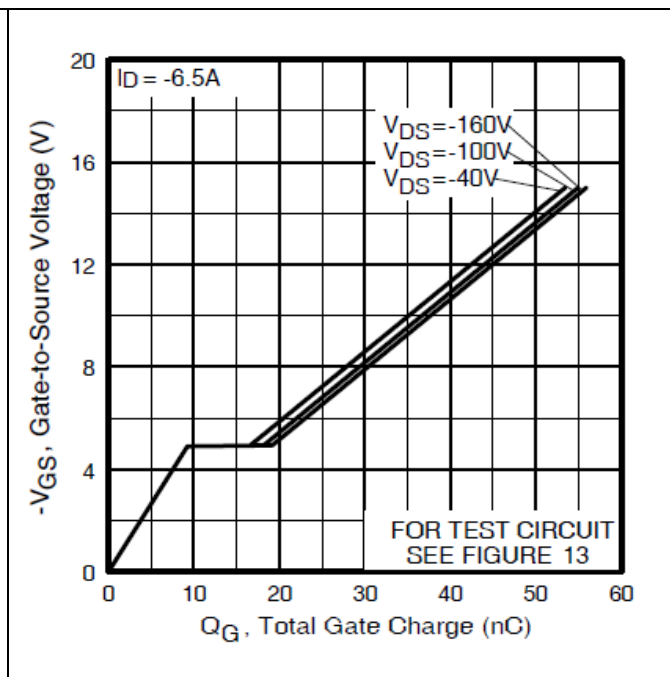


Figure 7 Typical Gate Charge Vs. Gate-to-Source Voltage

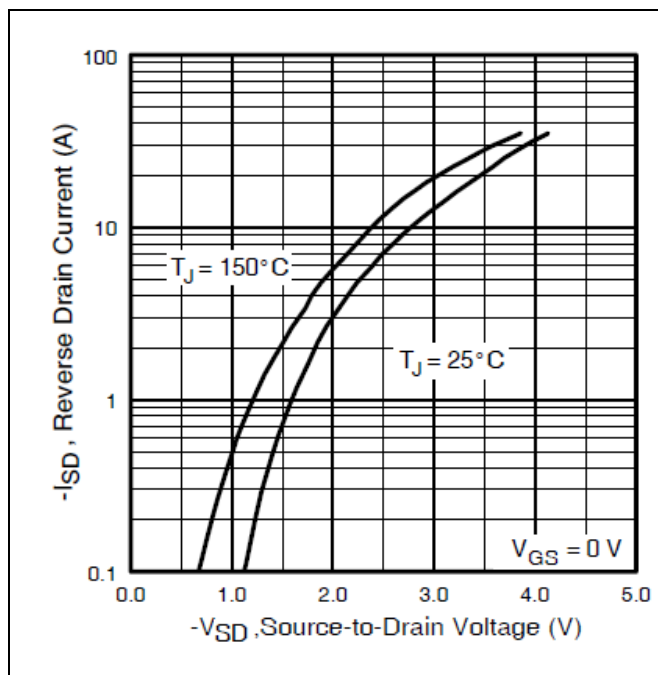


Figure 8 Typical Source-Drain Vs. Diode Forward Voltage

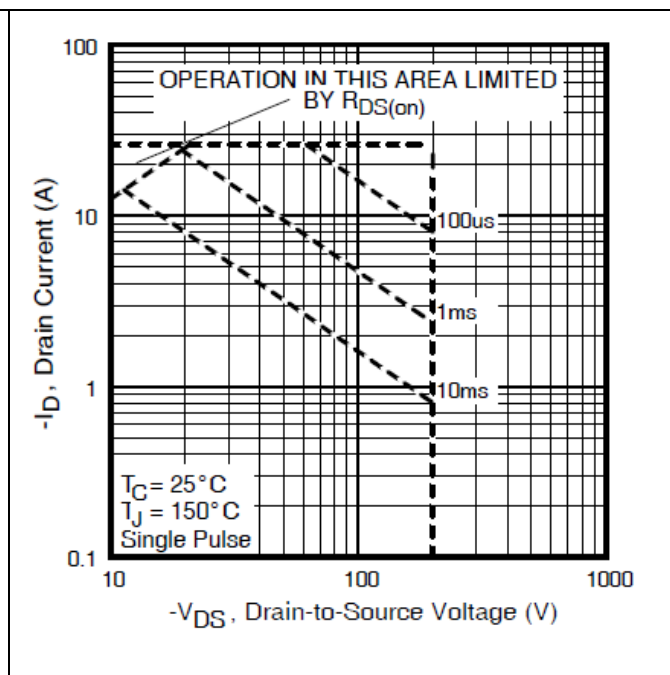


Figure 9 Maximum Safe Operating Area

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Radiation Hardened Power MOSFET THRU-HOLE (TO-257AA)

Electrical Characteristics Curves (Pre-irradiation)

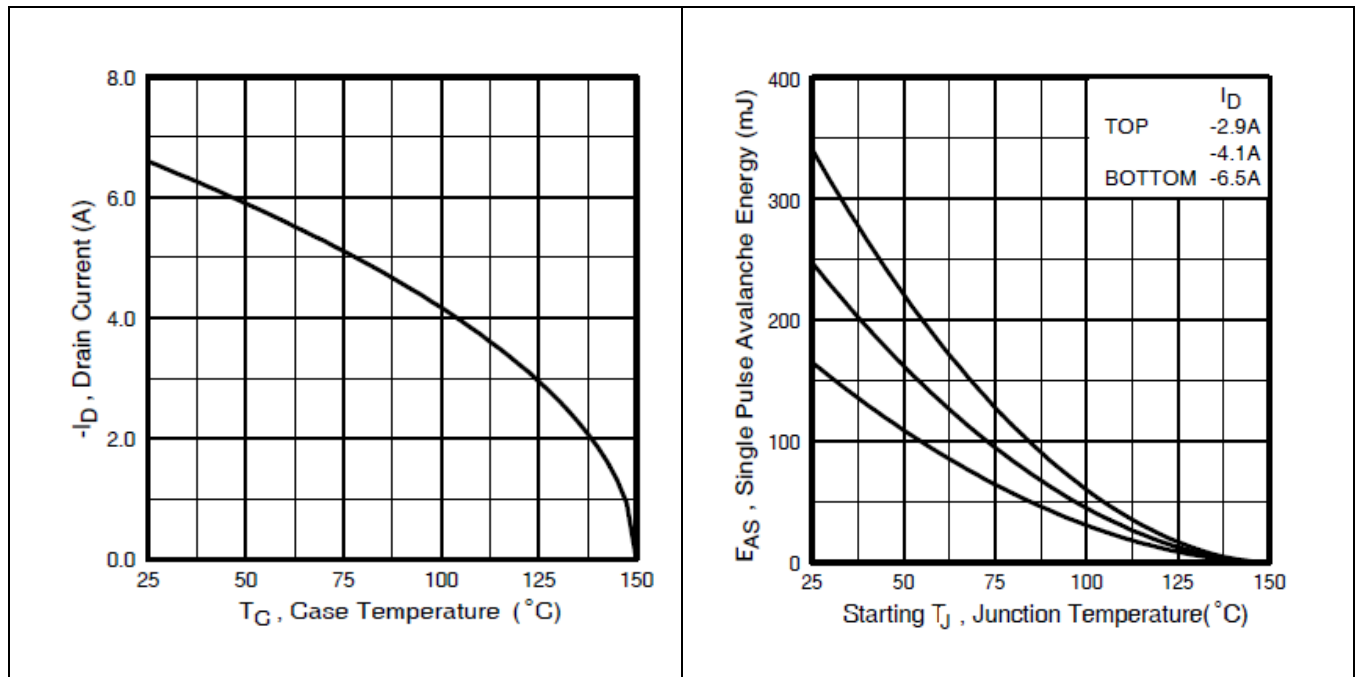


Figure 10 Maximum Drain Current Vs. Case Temperature

Figure 11 Maximum Avalanche Energy Vs. Drain Current

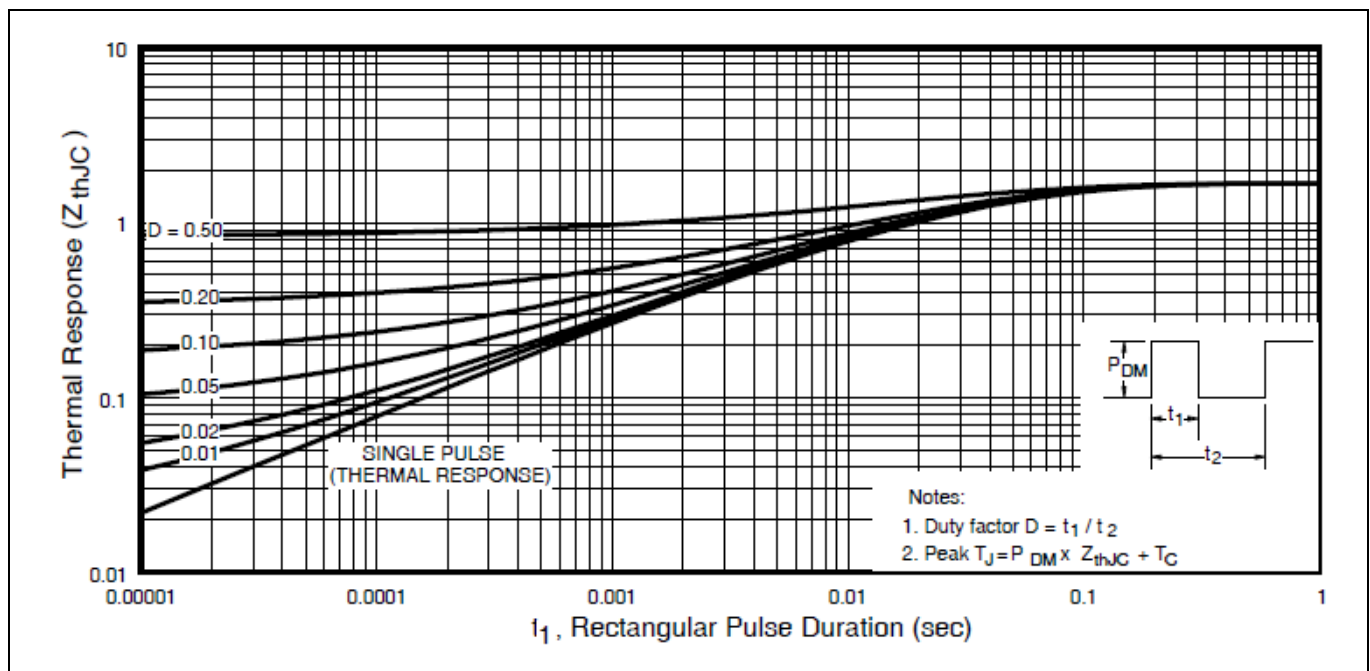


Figure 12 Maximum Effective Transient Thermal Impedance, Junction-to-Case

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Radiation Hardened Power MOSFET THRU-HOLE (TO-257AA)

Test Circuits (Pre-irradiation)

4 Test Circuits (Pre-irradiation)

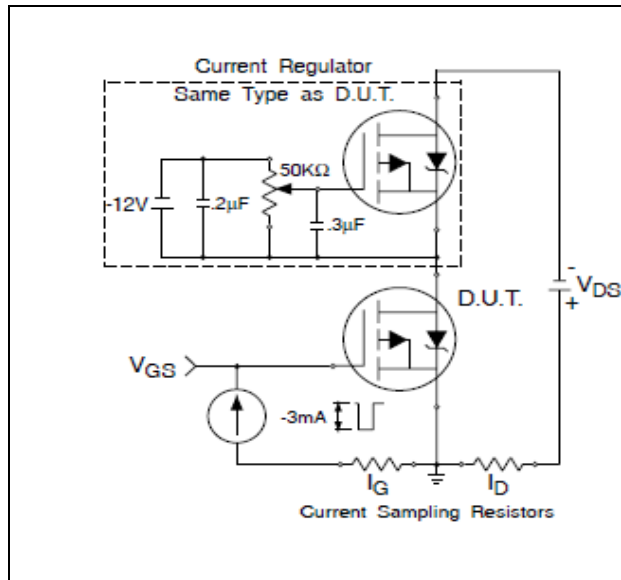


Figure 13 Gate Charge Test Circuit

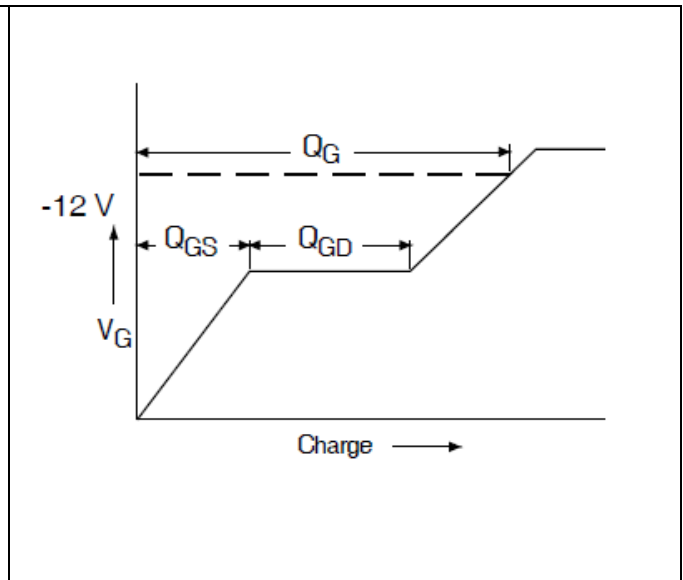


Figure 14 Gate Charge Waveform

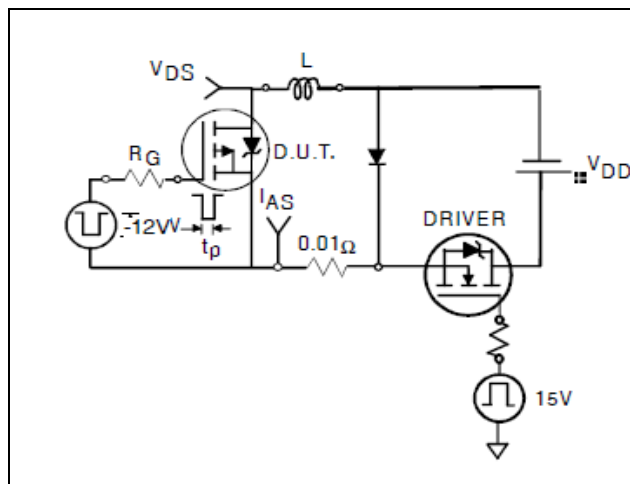


Figure 15 Unclamped Inductive Test Circuit

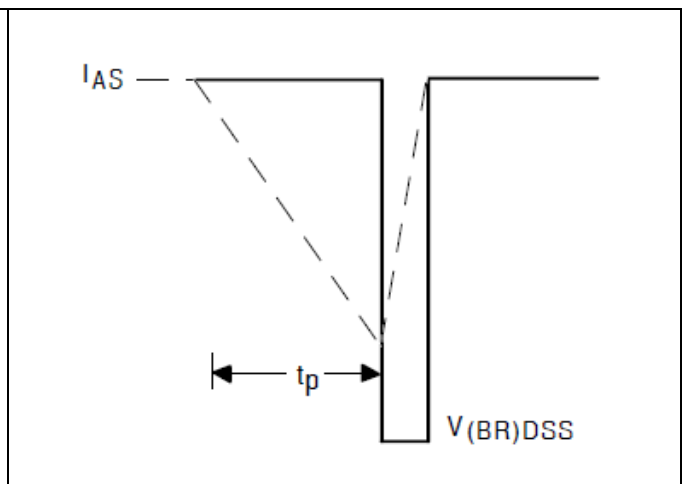


Figure 16 Unclamped Inductive Waveform

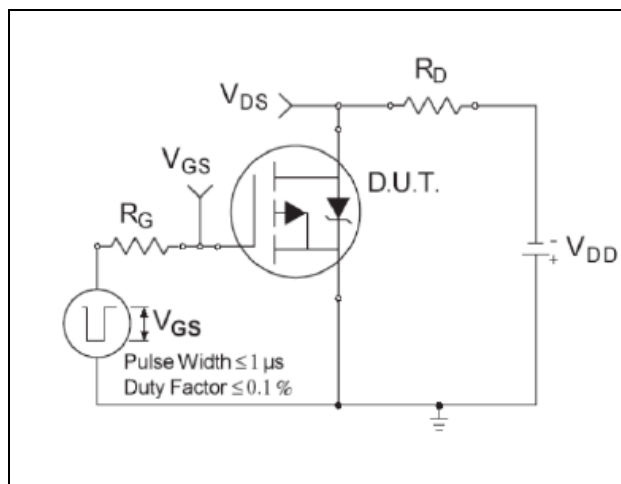


Figure 17 Switching Time Test Circuit

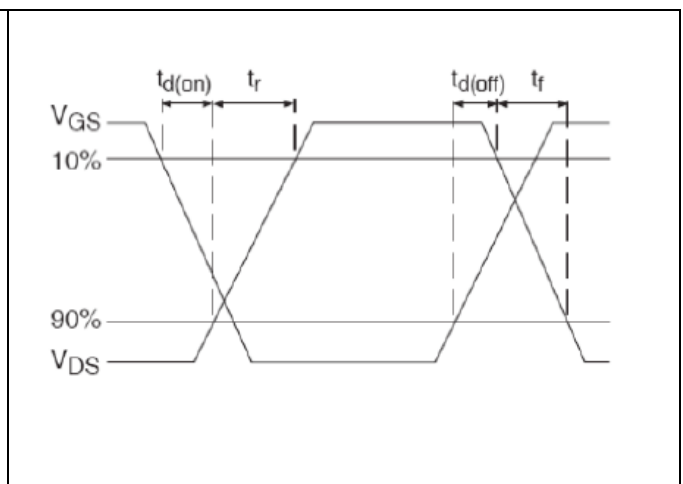
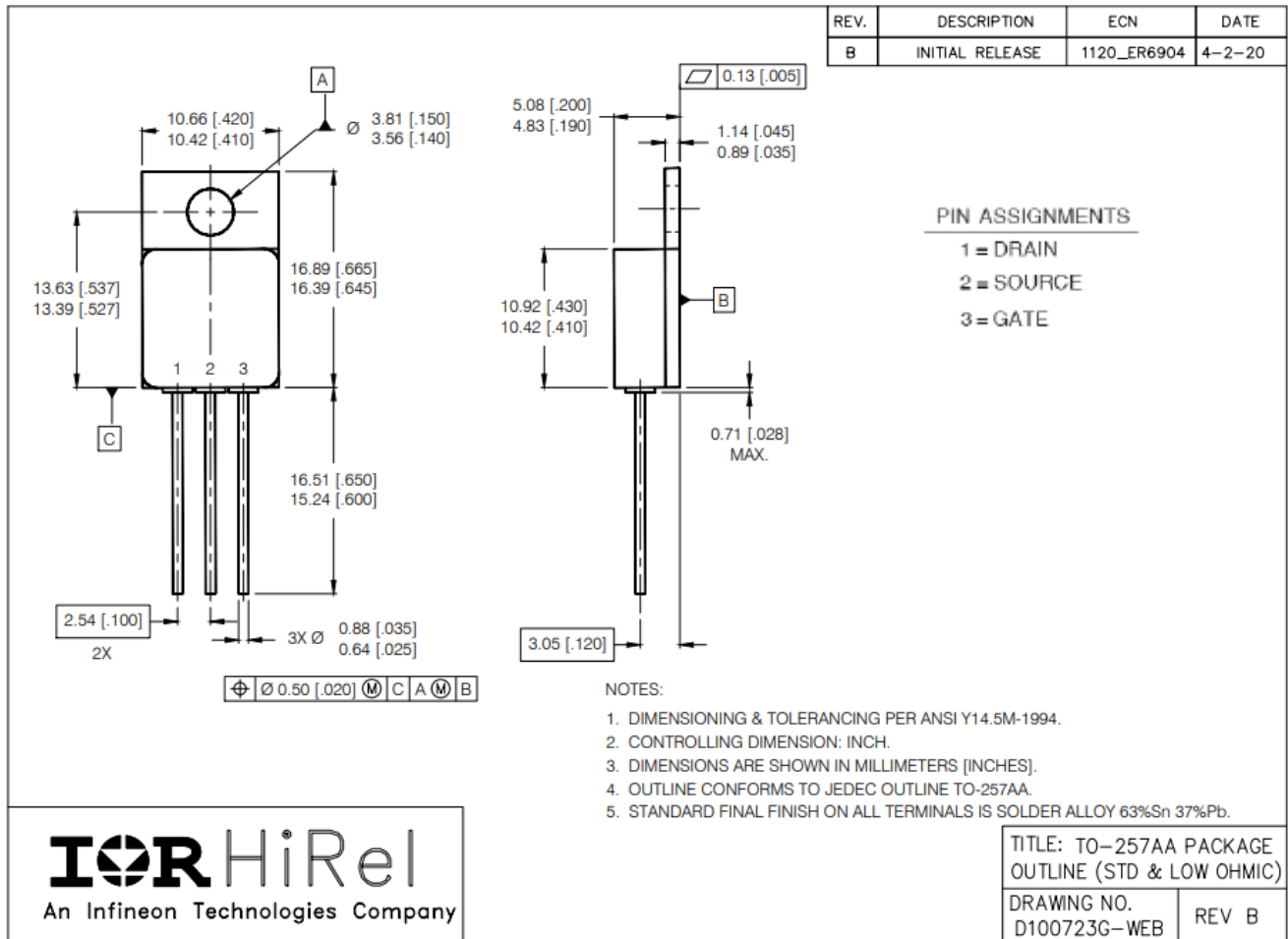


Figure 18 Switching Time Waveforms

Package Outline

5 Package Outline

Note: For the most updated package outline, please see the website: [TO-257AA](http://www.infineon.com/toc-257aa)



Revision history**Revision history**

Document version	Date of release	Description of changes
	12/05/2000	Final datasheet (PD-91401)
Rev A	06/09/2021	Updated per ECN-1120-08593

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Edition 2021-06-09

Published by

**International Rectifier HiRel Products,
Inc.**

**An Infineon Technologies company
El Segundo, California 90245 USA**

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