

# IRHYS67230CM (JANSR2N7592T3)

PD-96925D

## Radiation Hardened Power MOSFET Thru-Hole (Low-Ohmic TO-257AA) 200V, 16A, N-channel, R6 Technology

### Features

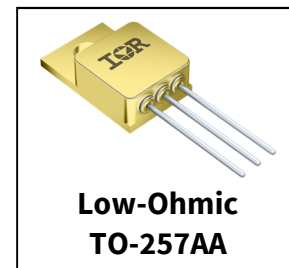
- Single event effect (SEE) hardened
- Low  $R_{DS(on)}$
- Fast switching
- Low total gate charge
- Simple drive requirements
- Hermetically sealed
- Ceramic eyelets
- Light weight
- Electrically Isolated

### Potential Applications

- DC-DC converter
- Motor drives

### Product Summary

- **Part number:** IRHYS67230CM  
IRHYS63230CM
- **Radiation level:** 100 krad(Si),  
300 krad(Si)
- **$R_{DS(on),max}$ :** 130m $\Omega$
- **$I_D$ :** 16A



### Product Validation

Qualified to JANS screening flow according to MIL-PRF-19500 for space applications

### Description

IR HiRel R6 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
IRHYS67230CM	TO-257AA	COTS	100 krad(Si)
IRHYS67230CMSCS	TO-257AA	S-Level	100 krad(Si)
JANSR2N7592T3	TO-257AA	JANS	100 krad(Si)
IRHYS63230CM	TO-257AA	COTS	300 krad(Si)
IRHYS63230CMSCS	TO-257AA	S-Level	300 krad(Si)

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## 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	16	A
$I_{D2} @ V_{GS} = 12V, T_C = 100^\circ C$	Continuous Drain Current	10	A
$I_{DM} @ T_C = 25^\circ C$	Pulsed Drain Current <sup>1</sup>	64	A
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	75	W
	Linear Derating Factor	0.6	W/°C
$V_{GS}$	Gate-to-Source Voltage	$\pm 20$	V
$E_{AS}$	Single Pulse Avalanche Energy <sup>2</sup>	83	mJ
$I_{AR}$	Avalanche Current <sup>1</sup>	16	A
$E_{AR}$	Repetitive Avalanche Energy <sup>1</sup>	7.5	mJ
dv/dt	Peak Diode Reverse Recovery <sup>3</sup>	9.0	V/ns
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Lead Temperature	300 (0.063 in. /1.6 mm from case for 10s)	
	Weight	4.3 (Typical)	

<sup>1</sup> Repetitive Rating; Pulse width limited by maximum junction temperature.

<sup>2</sup>  $V_{DD} = 25V$ , starting  $T_J = 25^\circ C$ ,  $L = 0.65mH$ , Peak  $I_L = 16A$ ,  $V_{GS} = 12V$

<sup>3</sup>  $I_{SD} \leq 16A$ ,  $di/dt \leq 750A/\mu s$ ,  $V_{DD} \leq 200V$ ,  $T_J \leq 150^\circ C$

## 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	—	0.19	—	V/ $^\circ\text{C}$	Reference to $25^\circ\text{C}$ , $I_D = 1.0mA$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	0.13	$\Omega$	$V_{GS} = 12V, I_{D2} = 10A^1$
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{DS} = V_{GS}, I_D = 1mA$
$\Delta V_{GS(th)}/\Delta T_J$	Gate Threshold Voltage Coefficient	—	-9.76	—	mV/ $^\circ\text{C}$	
Gfs	Forward Transconductance	11	—	—	S	$V_{DS} = 15V, I_{D2} = 10A^1$
$I_{DSS}$	Zero Gate Voltage Drain Current	—	—	10	$\mu\text{A}$	$V_{DS} = 160V, V_{GS} = 0V$
		—	—	25		$V_{DS} = 160V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Leakage Forward	—	—	100	nA	$V_{GS} = 20V$
	Gate-to-Source Leakage Reverse	—	—	-100		$V_{GS} = -20V$
$Q_G$	Total Gate Charge	—	—	42	nC	$I_{D1} = 16A$ $V_{DS} = 100V$ $V_{GS} = 12V$
$Q_{GS}$	Gate-to-Source Charge	—	—	10		
$Q_{GD}$	Gate-to-Drain ('Miller') Charge	—	—	20		
$t_{d(on)}$	Turn-On Delay Time	—	—	15	ns	$I_{D1} = 16A^{**}$ $V_{DD} = 100V$ $R_G = 7.5\Omega$ $V_{GS} = 12V$
$t_r$	Rise Time	—	—	40		
$t_{d(off)}$	Turn-Off Delay Time	—	—	35		
$t_f$	Fall Time	—	—	15		
$L_s + L_D$	Total Inductance	—	6.8	—	nH	Measured from Drain lead (6mm / 0.025 in from package) to Source lead (6mm / 0.025 in from package)
$C_{iss}$	Input Capacitance	—	1660	—	pF	$V_{GS} = 0V$ $V_{DS} = 25V$ $f = 1.0MHz$
$C_{oss}$	Output Capacitance	—	206	—		
$C_{rss}$	Reverse Transfer Capacitance	—	2.6	—		
$R_G$	Gate Resistance	—	1.75	—	$\Omega$	$f = 1.0MHz$ , open drain

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

<sup>1</sup> Pulse width  $\leq 300 \mu\text{s}$ ; 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)	—	—	16	A	
$I_{SM}$	Pulsed Source Current (Body Diode) <sup>1</sup>	—	—	64	A	
$V_{SD}$	Diode Forward Voltage	—	—	1.2	V	$T_J = 25^\circ\text{C}$ , $I_S = 16\text{A}$ , $V_{GS} = 0\text{V}$ <sup>2</sup>
$t_{rr}$	Reverse Recovery Time	—	—	300	ns	$T_J = 25^\circ\text{C}$ , $I_F = 16\text{A}$ , $V_{DD} \leq 25\text{V}$
$Q_{rr}$	Reverse Recovery Charge	—	—	3.2	$\mu\text{C}$	$di/dt = 100\text{A}/\mu\text{s}$ <sup>2</sup>
$t_{on}$	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 (Typical Socket Mount)	—	—	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<sup>3, 4</sup>

Symbol	Parameter	Up to 300 krad(Si) <sup>5</sup>		Unit	Test Conditions
		Min.	Max.		
$BV_{DSS}$	Drain-to-Source Breakdown Voltage	200	—	V	$V_{GS} = 0\text{V}$ , $I_D = 1.0\text{mA}$
$V_{GS(th)}$	Gate Threshold Voltage	2.0	4.0	V	$V_{DS} = V_{GS}$ , $I_D = 1.0\text{mA}$
$I_{GSS}$	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	—	10	$\mu\text{A}$	$V_{DS} = 160\text{V}$ , $V_{GS} = 0\text{V}$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-3) <sup>2</sup>	—	0.134	$\Omega$	$V_{GS} = 12\text{V}$ , $I_{D2} = 10\text{A}$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-257AA) <sup>2</sup>	—	0.130	$\Omega$	$V_{GS} = 12\text{V}$ , $I_{D2} = 10\text{A}$
$V_{SD}$	Diode Forward Voltage	—	1.2	V	$V_{GS} = 0\text{V}$ , $I_F = 16\text{A}$

<sup>1</sup> Repetitive Rating; Pulse width limited by maximum junction temperature.

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

<sup>3</sup> 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.

<sup>4</sup> 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.

<sup>5</sup> Part number(s) : IRHYS67230CM and IRHYS63230CM

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

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> = -4V	V <sub>GS</sub> = -5V	V <sub>GS</sub> = -10V	V <sub>GS</sub> = -15V
42 ± 5%	2450 ± 5%	205 ± 5%	200	200	200	200	190
61 ± 5%	825 ± 5%	66 ± 7.5%	200	200	200	200	190
90 ± 5%	1470 ± 5%	80 ± 5%	150	150	110	—	—

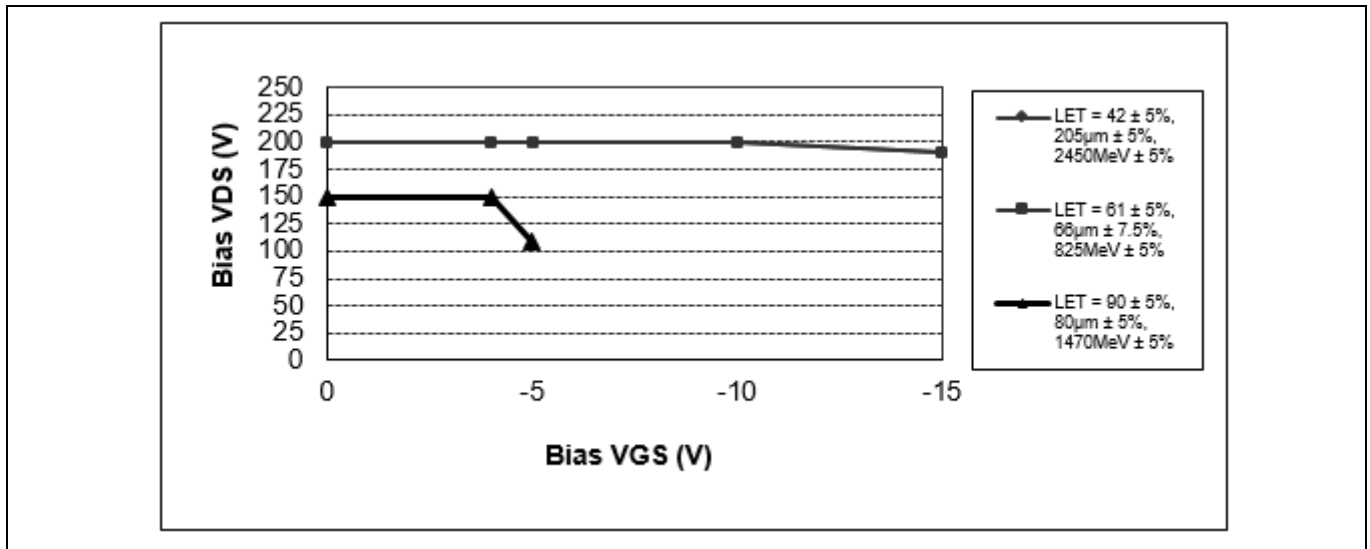


Figure 1 Typical Single Event Effect, Safe Operating Area

### 3 Electrical Characteristics Curves (Pre-irradiation)

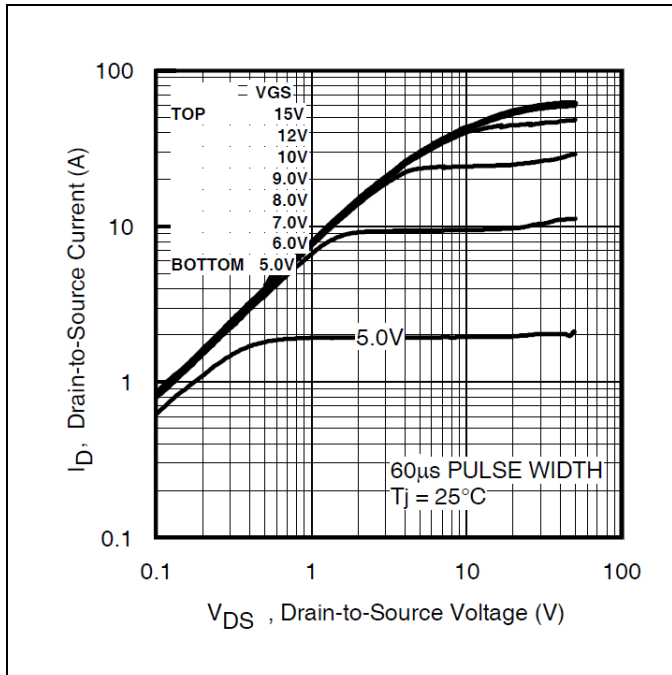


Figure 2 Typical Output Characteristics

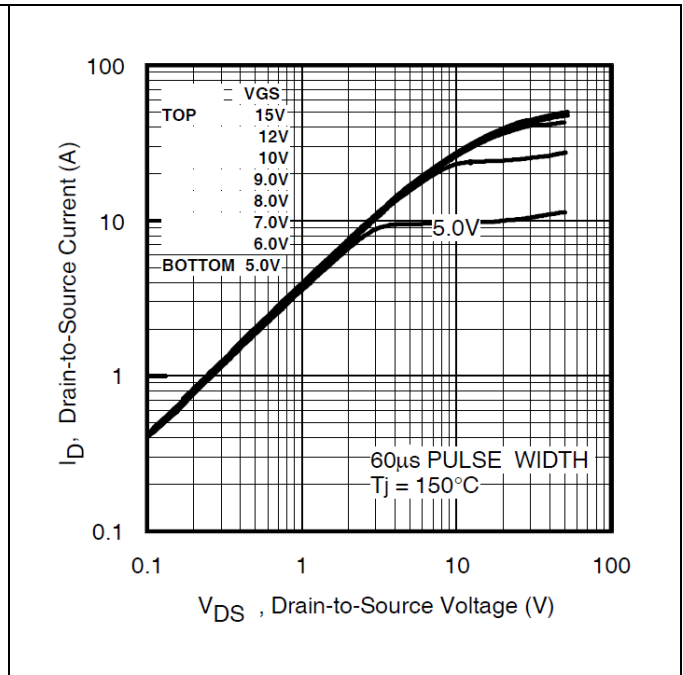


Figure 3 Typical Output Characteristics

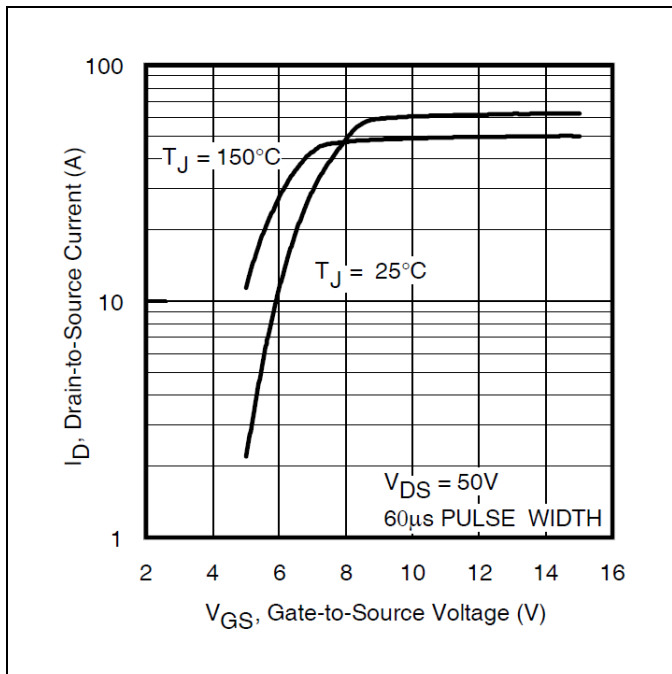


Figure 4 Typical Transfer Characteristics

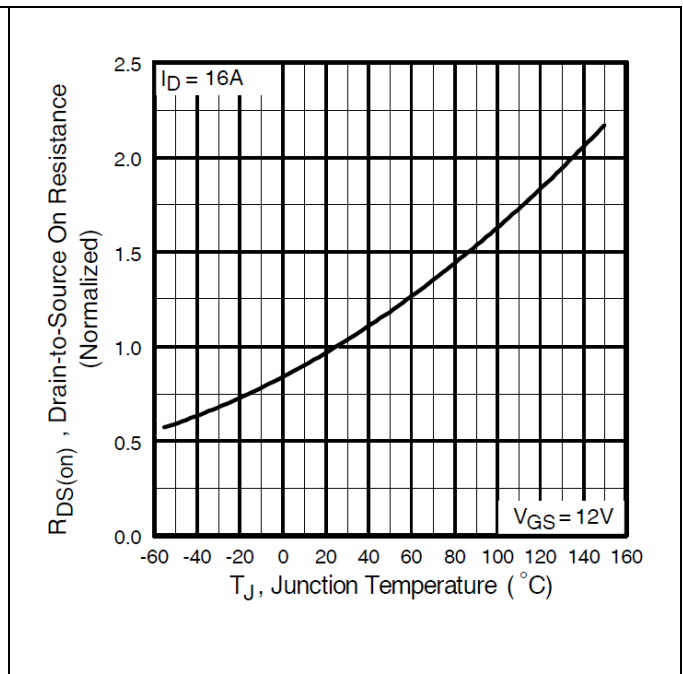
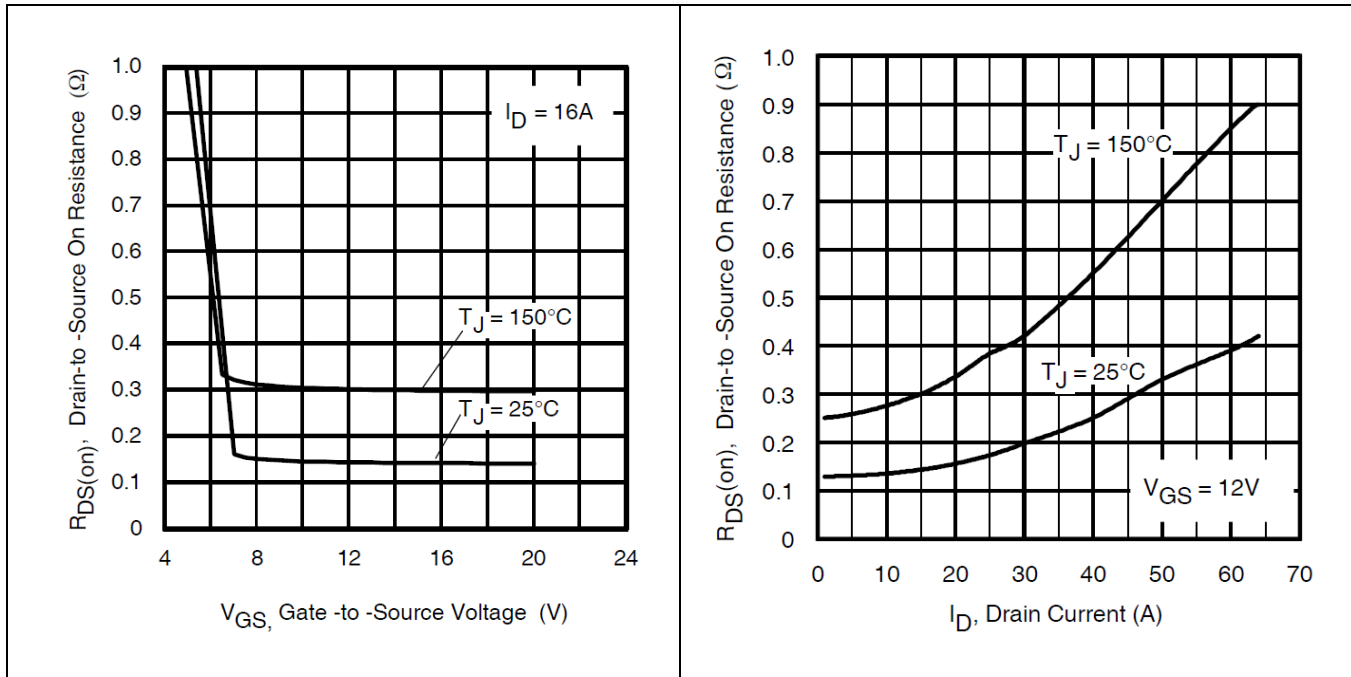


Figure 5 Normalized On-Resistance Vs. Temperature

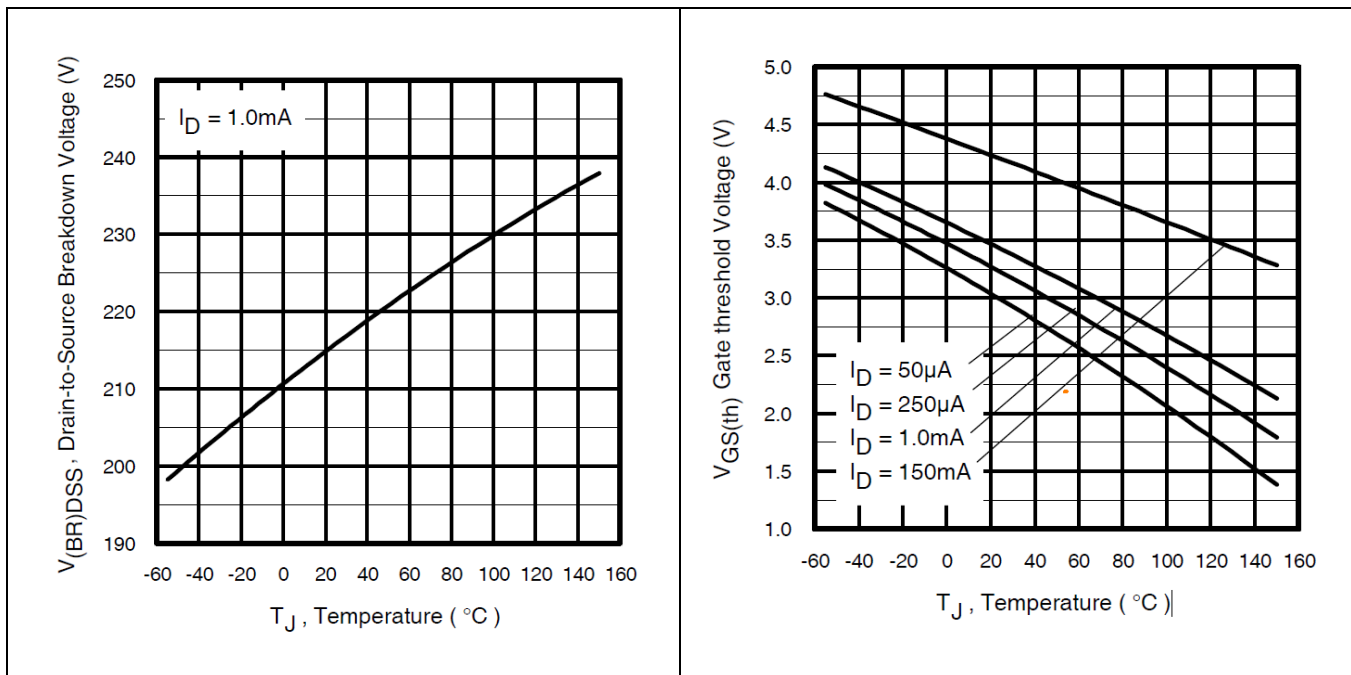
**IRHYS67230CM (JANSR2N7592T3)**

**Radiation Hardened Power MOSFET Thru-Hole (Low-Ohmic TO-257AA)**

**Electrical Characteristics Curves (Pre-irradiation)**



**Figure 6 Typical On-Resistance Vs. Gate Voltage** **Figure 7 Typical On-Resistance Vs. Drain Current**



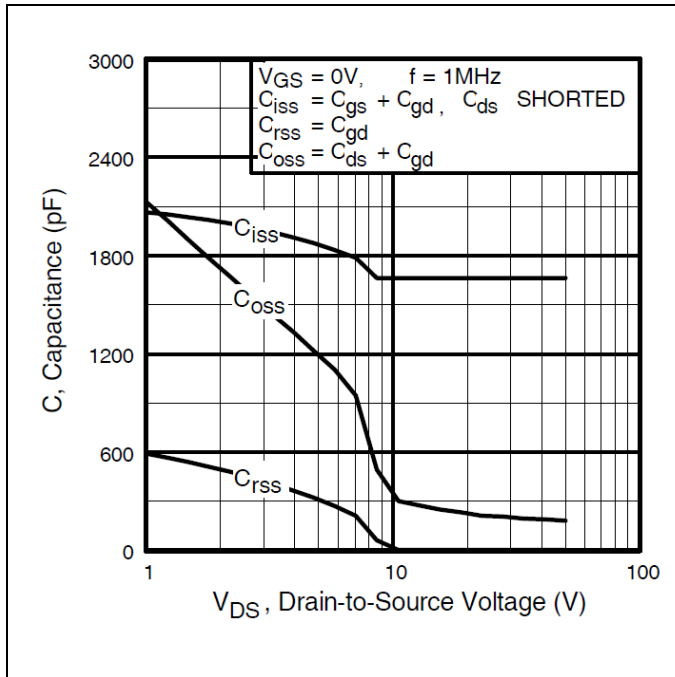
**Figure 8 Typical Drain-to-Source Breakdown Voltage Vs. Temperature** **Figure 9 Typical Threshold Voltage Vs. Temperature**



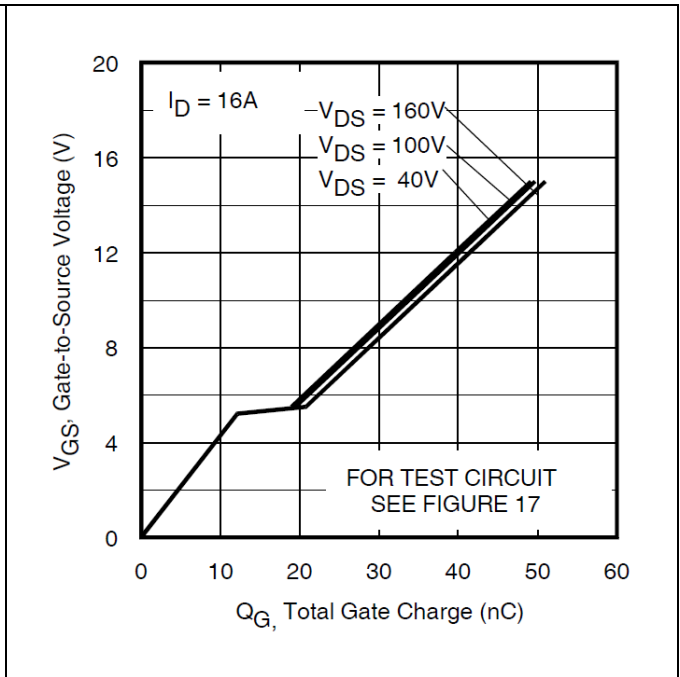
**IRHYS67230CM (JANSR2N7592T3)**

**Radiation Hardened Power MOSFET Thru-Hole (Low-Ohmic TO-257AA)**

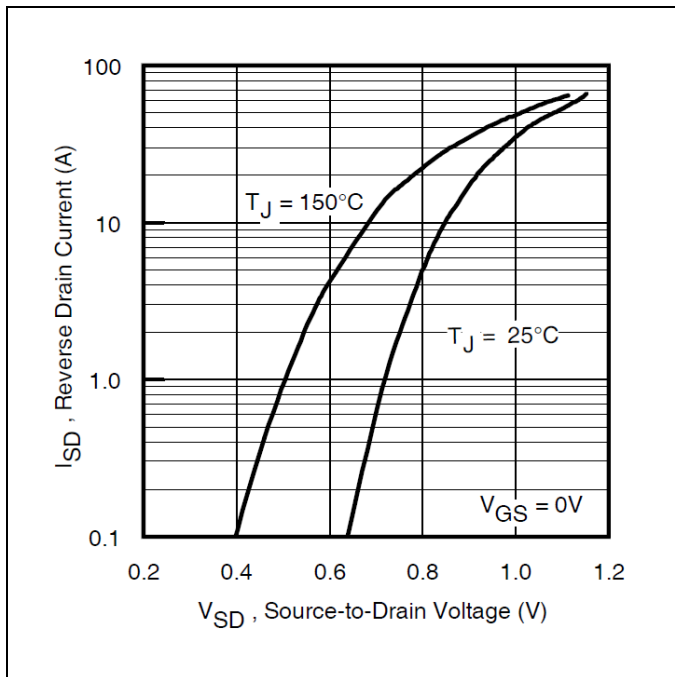
**Electrical Characteristics Curves (Pre-irradiation)**



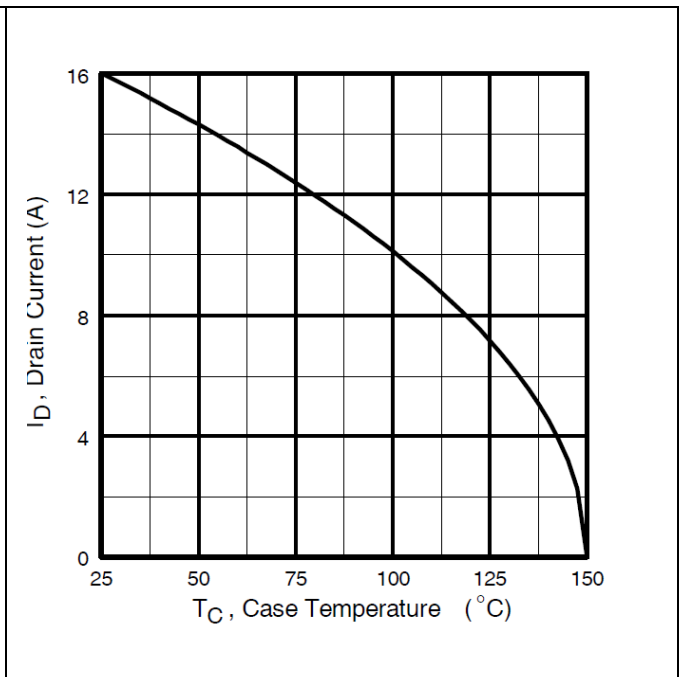
**Figure 10 Typical Capacitance Vs. Drain-to-Source Voltage**



**Figure 11 Gate-to-Source Voltage Vs. Typical Gate Charge**



**Figure 12 Typical Source-Drain Current Vs. Diode Forward Voltage**

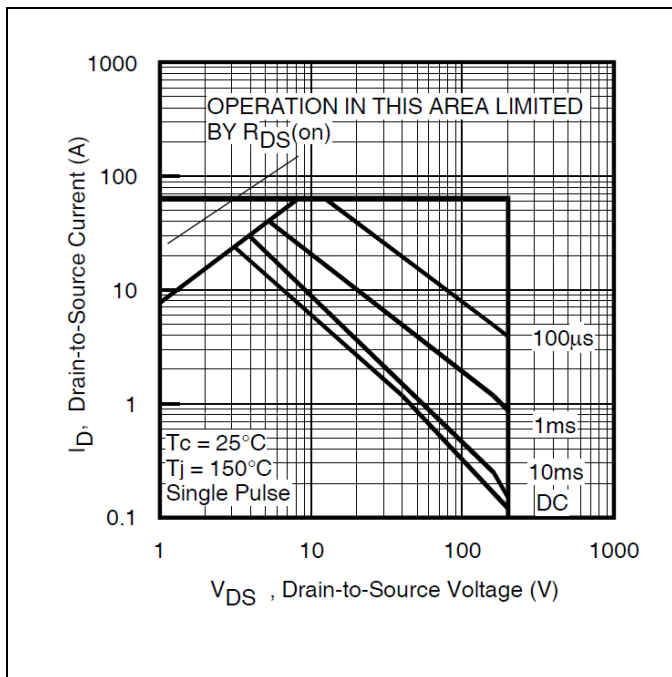


**Figure 13 Maximum Drain Current Vs. Case Temperature**

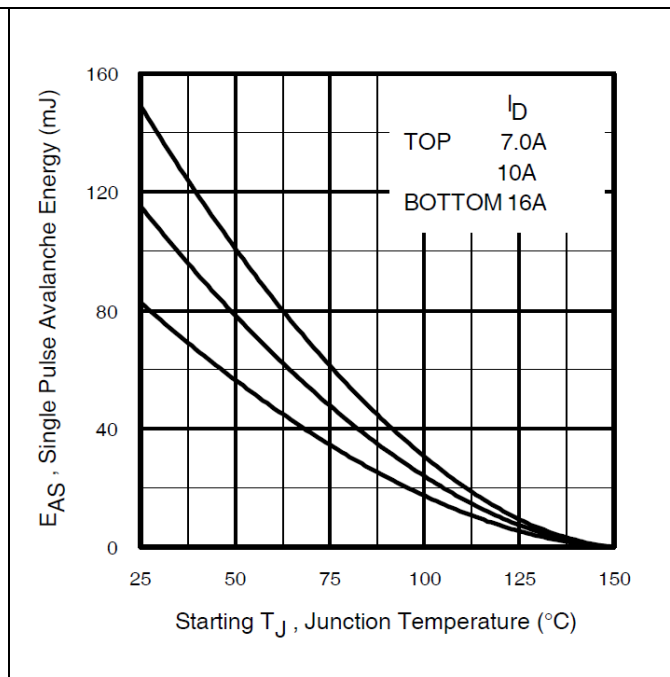
**IRHYS67230CM (JANSR2N7592T3)**

**Radiation Hardened Power MOSFET Thru-Hole (Low-Ohmic TO-257AA)**

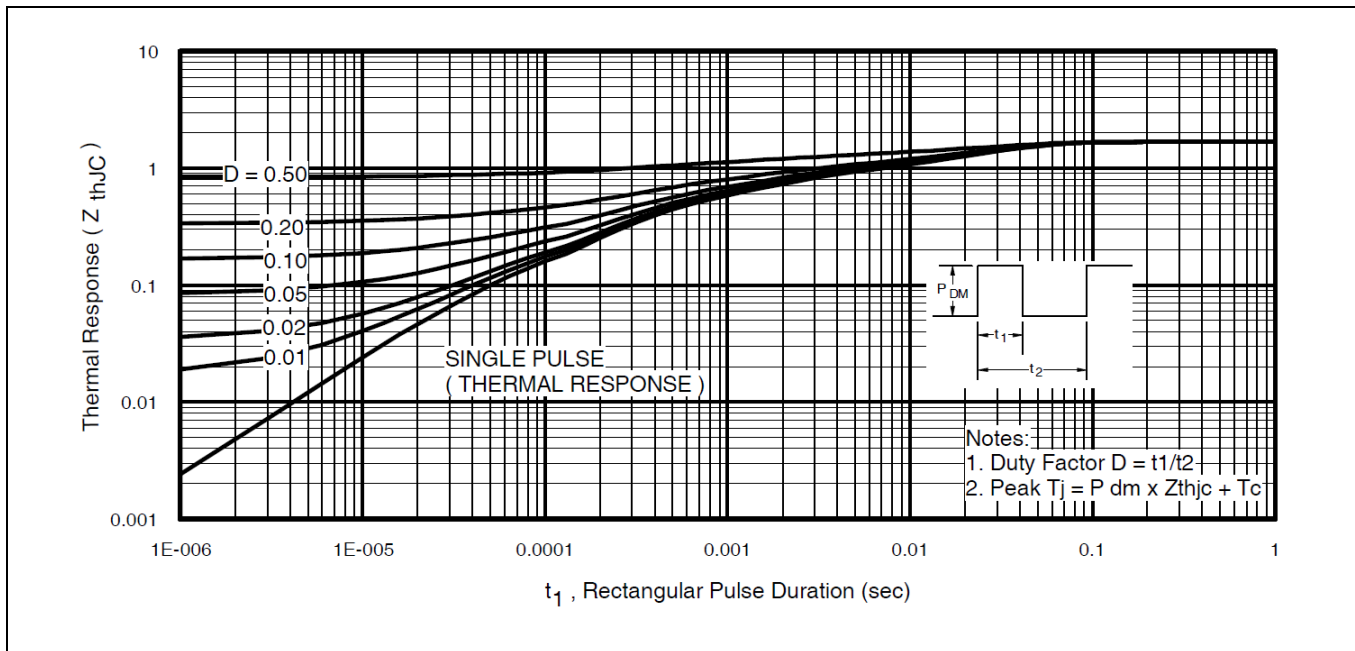
**Electrical Characteristics Curves (Pre-irradiation)**



**Figure 14 Maximum Safe Operating Area**



**Figure 15 Maximum Avalanche Energy Vs. Junction Temperature**



**Figure 16 Maximum Effective Transient Thermal Impedance, Junction-to-Case**

# IRHYS67230CM (JANSR2N7592T3)

## Radiation Hardened Power MOSFET Thru-Hole (Low-Ohmic TO-257AA)

### Test Circuits (Pre-irradiation)

#### 4 Test Circuits (Pre-irradiation)

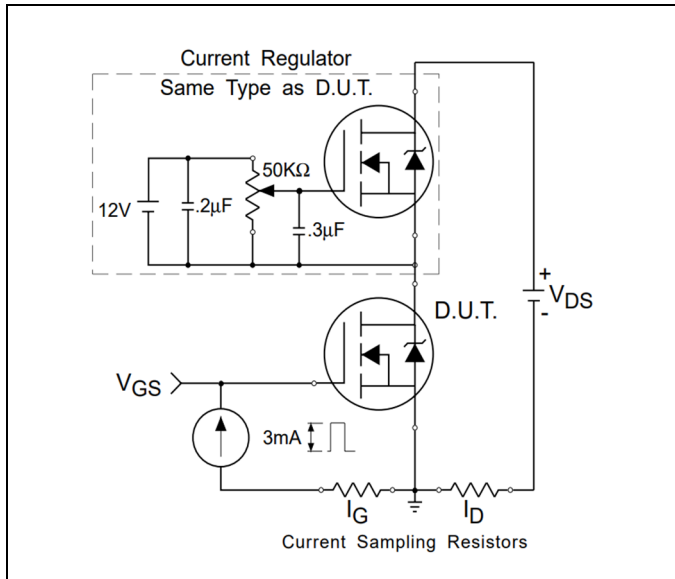


Figure 17 Gate Charge Test Circuit

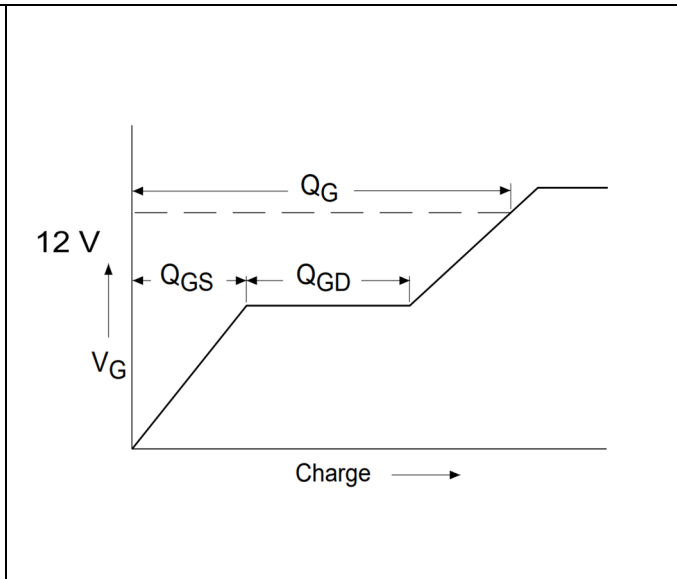


Figure 18 Gate Charge Waveform

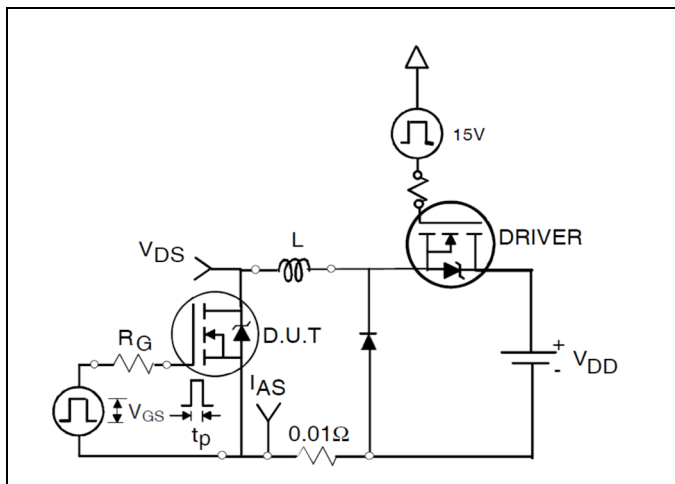


Figure 19 Unclamped Inductive Test Circuit

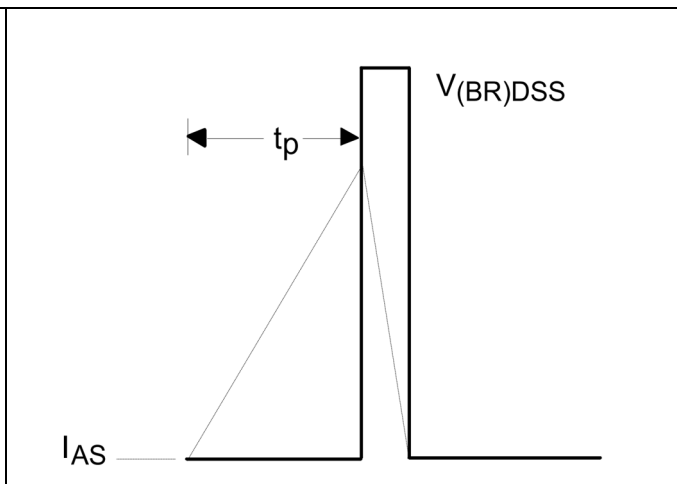


Figure 20 Unclamped Inductive Waveform

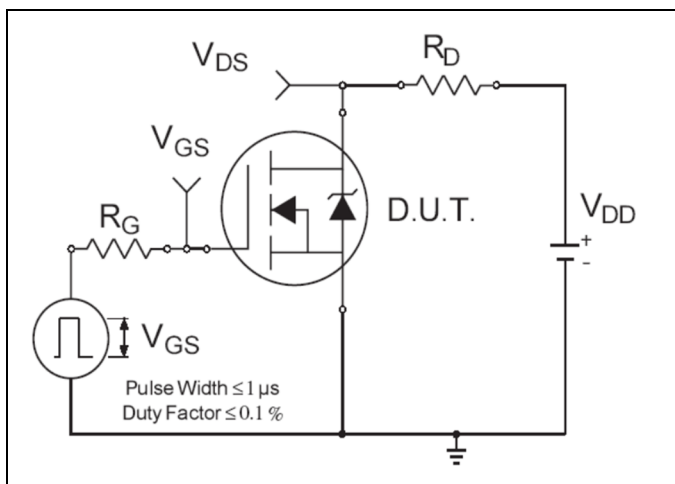


Figure 21 Switching Time Test Circuit

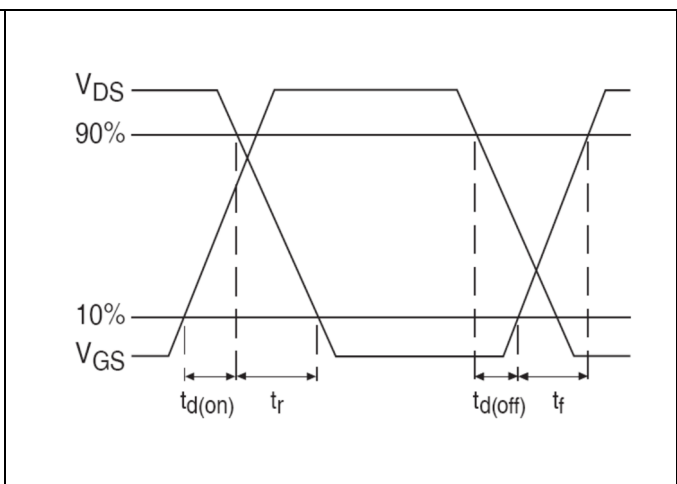
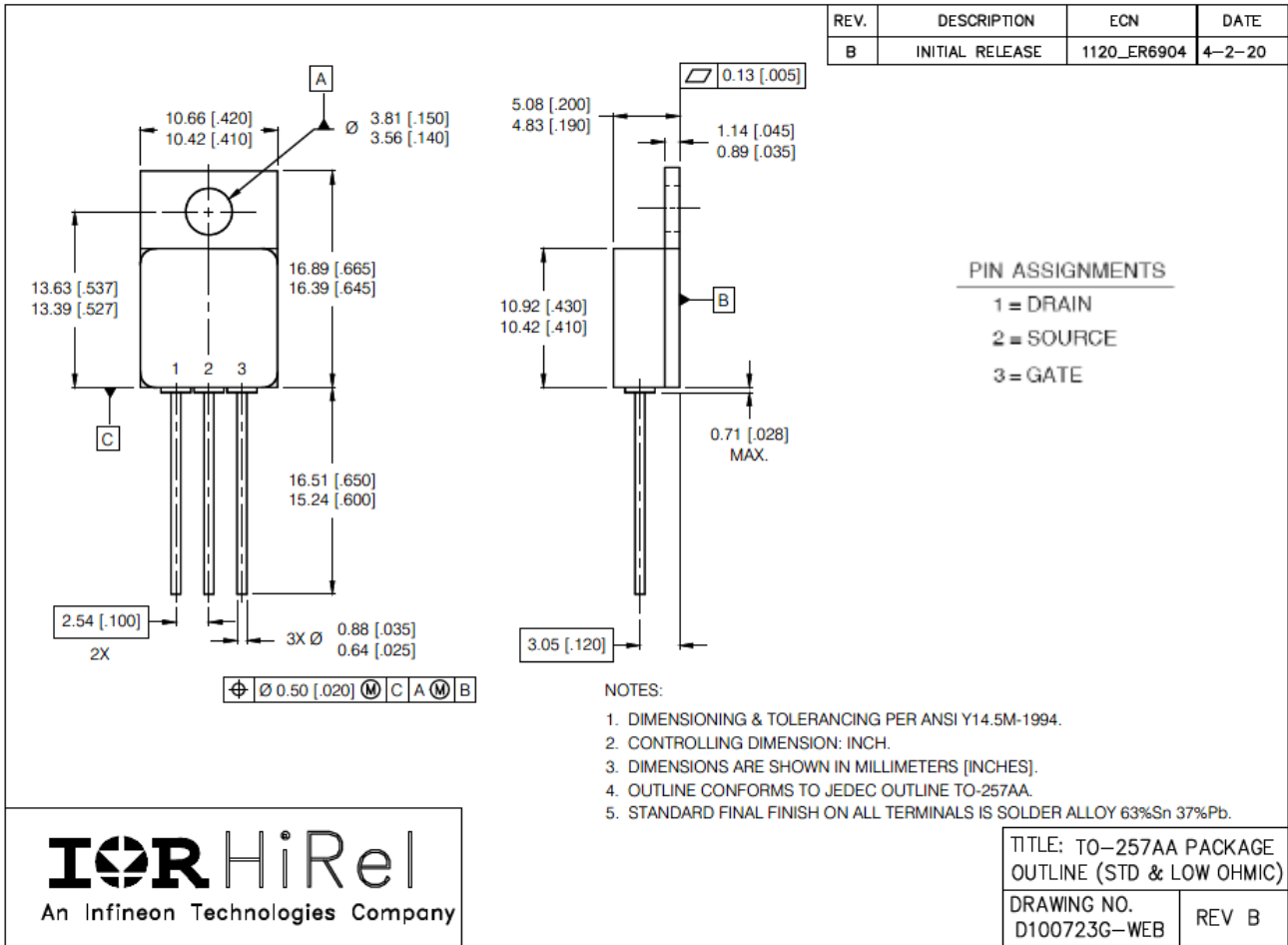


Figure 22 Switching Time Waveforms

Package Outline

# 5 Package Outline

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



**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.

**Package Outline****Revision history**

<b>Document version</b>	<b>Date of release</b>	<b>Description of changes</b>
	11/17/2004	Datasheet (PD-96925)
Rev A	03/17/2006	Updated SEE table and Fig1 -page6
Rev B	01/19/2007	Updated based on ECN-14400
Rev C	06/15/2010	Updated based on ECN-17282
Rev D	08/06/2021	Updated based on ECN-1120_08663

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