IRHYB67130CM

PD-95841D

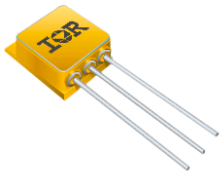
Radiation Hardened Power MOSFET
Thru-Hole (TO-257AA Tabless Low Ohmic)
100V, 20A, N-channel, R6 Technology

Features

- Single event effect (SEE) hardened
- Low $R_{DS\,(on)}$
- Low total gate charge
- Fast switching
- Simple drive requirements
- Hermetically sealed
- Electrically isolated
- Light weight
- ESD rating: Class 1C per MIL-STD-750, Method 1020

Product Summary

- **BV_{DSS}:** 100V
- **I_D:** 20A
- **$R_{DS\,(on),\,max}$:** 42mΩ
- **$Q_{G,\,max}$:** 50nC



TO-257AA Tabless Low Ohmic

Potential Applications

- Isolated DC-DC converters
- Motor drives
- Electric propulsion
- Thermal management

Product Validation

Adhered 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. These devices have been characterized for both Total Dose and Single Event Effect (SEE) with useful performance up to LET of 90 (MeV·cm^2/mg). The combination of low $R_{DS(on)}$ and low gate charge reduces the power losses in 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, fast switching and temperature stability of electrical parameters.

Ordering Information

Table 1 Ordering options

Part number	Package	Screening Level	TID Level
IRHYB67130CM	TO-257AA Tabless Low Ohmic	COTS	100 krad(Si)
IRHYB67130CMSCS	TO-257AA Tabless Low Ohmic	S-Level	100 krad(Si)
IRHYB63130CM	TO-257AA Tabless Low Ohmic	COTS	300 krad(Si)
IRHYB63130CMSCS	TO-257AA Tabless Low Ohmic	S-Level	300 krad(Si)

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1 Absolute Maximum Ratings

Table 2 Absolute Maximum Ratings (Pre-Irradiation)

Symbol	Parameter	Value	Unit
I_{D1} @ V_{GS} = 12V, T_C = 25°C	Continuous Drain Current	20*	A
I_{D2} @ V_{GS} = 12V, T_C = 100°C	Continuous Drain Current	19	A
I_{DM} @ T_C = 25°C	Pulsed Drain Current [1]	80	A
P_D @ T_C = 25°C	Maximum Power Dissipation	75	W
	Linear Derating Factor	0.6	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy [2]	107	mJ
I_{AR}	Avalanche Current [1]	20	A
E_{AR}	Repetitive Avalanche Energy [1]	7.5	mJ
dv/dt	Peak Diode Reverse Recovery [3]	5.5	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	3.7 (Typical)	g

* Current is limited by package

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

[2] V_{DD} = 25V, starting T_J = 25°C, L = 0.54mH, Peak I_L = 20A, V_{GS} = 12V

[3] $I_{SD} \leq$ 20A, di/dt ≤ 575A/µs, $V_{DD} \leq$ 100V, $T_J \leq$ 150°C

2 Device Characteristics

2.1 Electrical Characteristics (Pre-Irradiation)

Table 3 Static and Dynamic Electrical Characteristics @ T_j = 25°C (Unless Otherwise Specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	—	—	V	V_{GS} = 0V, I_D = 1.0mA
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.12	—	V/°C	Reference to 25°C, I_D = 1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	42	mΩ	V_{GS} = 12V, I_{D2} = 19A [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	—	-8.72	—	mV/°C	
Gfs	Forward Transconductance	14	—	—	S	V_{DS} = 15V, I_{D2} = 19A [1]
I_{DSS}	Zero Gate Voltage Drain Current	—	—	10	µA	V_{DS} = 80V, V_{GS} = 0V
		—	—	25		V_{DS} = 80V, V_{GS} = 0V, T_J = 125°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	—	—	50	nC	I_{D1} = 20A V_{DS} = 50V V_{GS} = 12V
Q_{GS}	Gate-to-Source Charge	—	—	15		
Q_{GD}	Gate-to-Drain ('Miller') Charge	—	—	12		
$t_{d(on)}$	Turn-On Delay Time	—	—	20	ns	I_{D1} = 20A ** V_{DD} = 50V R_G = 7.5Ω V_{GS} = 12V
t_r	Rise Time	—	—	50		
$t_{d(off)}$	Turn-Off Delay Time	—	—	35		
t_f	Fall Time	—	—	15		
$L_s + L_D$	Total Inductance	—	6.8	—	nH	Measured from Drain lead (6mm / 0.25 in from package) to Source lead (6mm/ 0.25 in from package) with Source wire internally bonded from Source pin to Drain pad
C_{iss}	Input Capacitance	—	1710	—	pF	V_{GS} = 0V V_{DS} = 25V f = 1.0MHz
C_{oss}	Output Capacitance	—	343	—		
C_{rss}	Reverse Transfer Capacitance	—	6.5	—		
R_G	Gate Resistance	—	1.1	—	Ω	f = 1.0MHz, open drain

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

[1] Pulse width ≤ 300 µs; Duty Cycle ≤ 2%

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)	—	—	20	A	
I_{SM}	Pulsed Source Current (Body Diode) [1]	—	—	80	A	
V_{SD}	Diode Forward Voltage	—	—	1.2	V	T_J = 25°C, I_S = 20A, V_{GS} = 0V [2]
t_{rr}	Reverse Recovery Time	—	—	250	ns	T_J = 25°C, I_F = 20A, V_{DD} ≤ 25V
Q_{rr}	Reverse Recovery Charge	—	—	2.7	µC	di/dt = 100A/µs
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	°C/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°C, Post Total Dose Irradiation [3, 4]

Symbol	Parameter	Up to 300 krad (Si) [5]		Unit	Test Conditions
		Min.	Max.		
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	—	V	V_{GS} = 0V, I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	2.0	4.0	V	V_{DS} = V_{GS}, I_D = 1.0mA
I_{GSS}	Gate-to-Source Leakage Forward	—	100	nA	V_{GS} = 20V
	Gate-to-Source Leakage Reverse	—	-100		V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	—	10	µA	V_{DS} = 80V, V_{GS} = 0V
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-3) [2]	—	45	mΩ	V_{GS} = 12V, I_{D2} = 19A
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-257AA Low Ohmic) [2]	—	42	mΩ	V_{GS} = 12V, I_{D2} = 19A
V_{SD}	Diode Forward Voltage	—	1.2	V	V_{GS} = 0V, I_F = 20A

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

[2] Pulse width ≤ 300 µs; Duty Cycle ≤ 2%

[3] Total Dose Irradiation with V_{GS} Bias. V_{GS} = 12V 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} = 80V applied and V_{GS} = 0 during irradiation per MIL-STD-750, Method 1019, condition A.

[5] Part numbers IRHYB67130CM and IRHYB63130CM

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·cm²/mg)	Energy (MeV)	Range (µm)	V_{DS} (V)					
			V_{GS} = 0V	V_{GS} =-5V	V_{GS} =-10V	V_{GS} =-15V	V_{GS} =-19V	V_{GS} =-20V
39 ± 5%	315 ± 5%	40 ± 5%	100	100	100	100	100	40
61 ± 5%	345 ± 5%	32 ± 7.5%	100	100	100	30	—	—
90 ± 5%	375 ± 7.5%	29 ±7. 5%	100	100	—	—	—	—

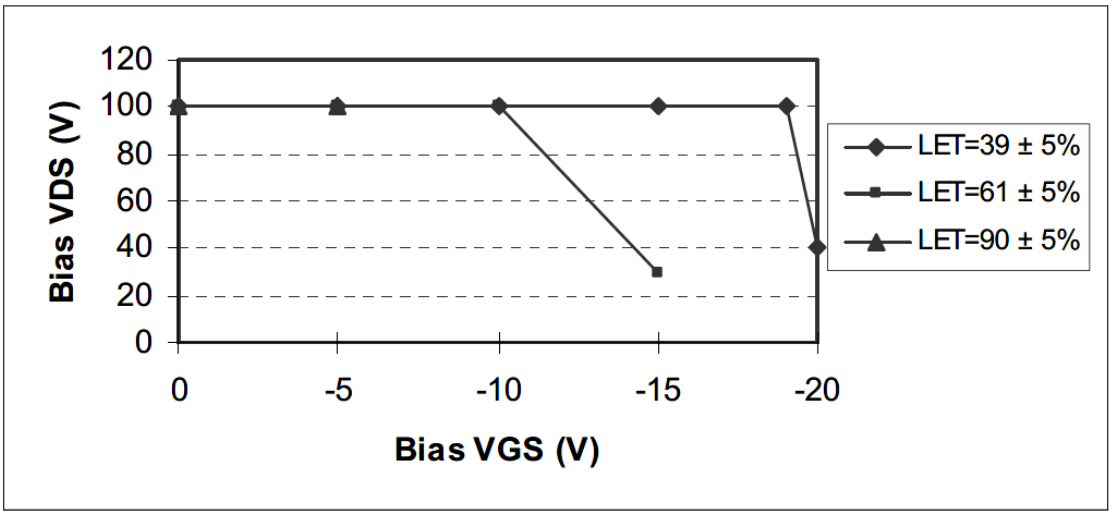


Figure 1 Typical Single Event Effect, Safe Operating Area

3 Electrical Characteristics Curves (Pre-irradiation)

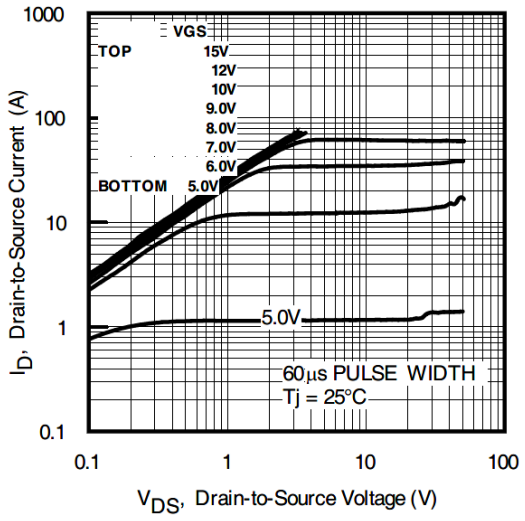


Figure 2 Typical Output Characteristics

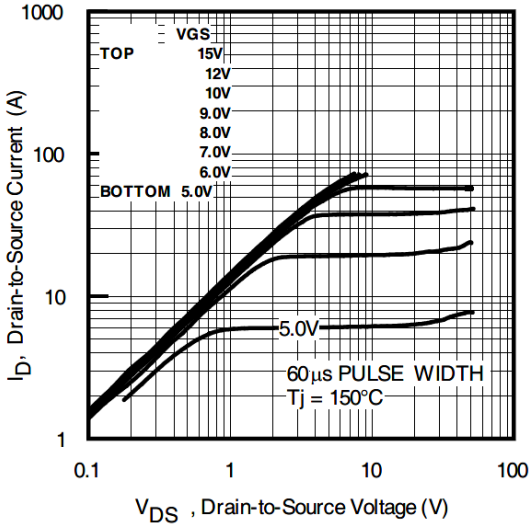


Figure 3 Typical Output Characteristics

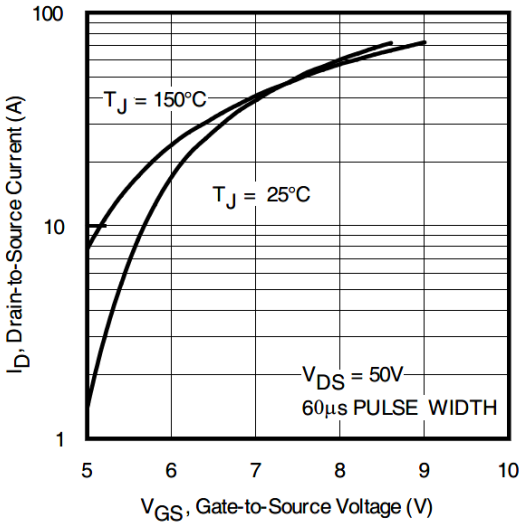


Figure 4 Typical Transfer Characteristics

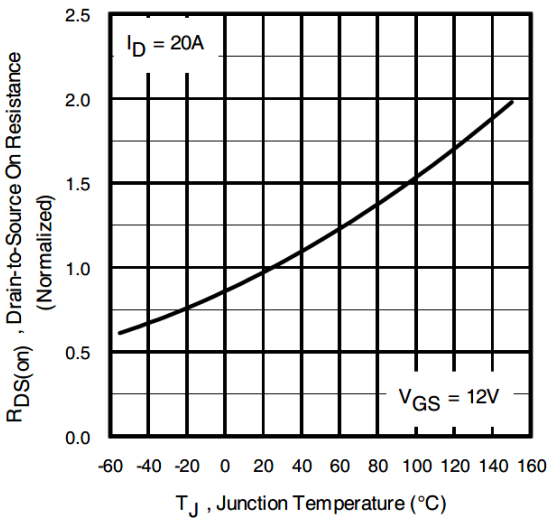


Figure 5 Normalized On-Resistance Vs. Temperature

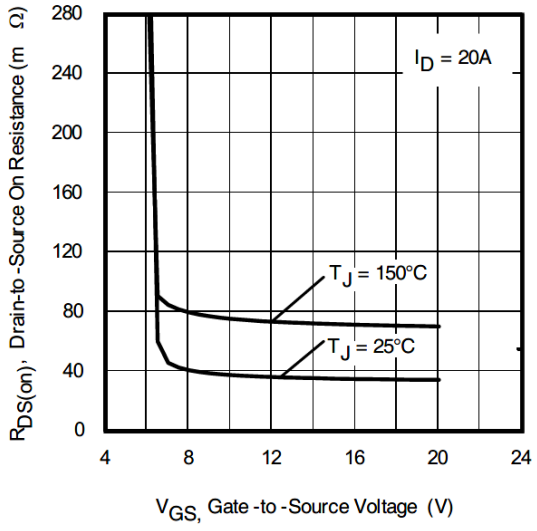


Figure 6 **Typical On-Resistance Vs. Gate Voltage**

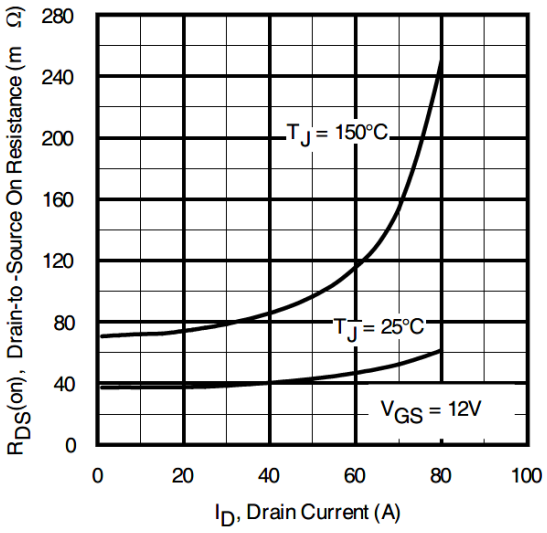


Figure 7 **Typical On-Resistance Vs. Drain Current**

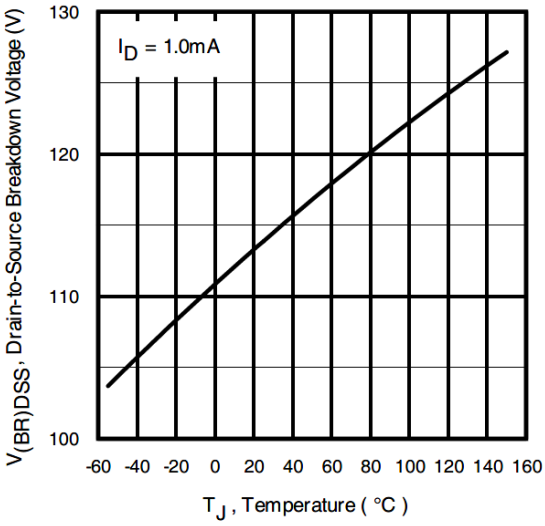


Figure 8 **Typical Drain-to-Source Breakdown Voltage Vs. Temperature**

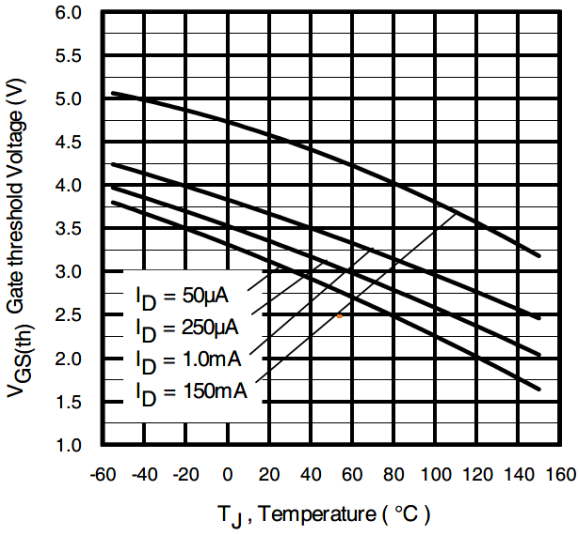


Figure 9 **Typical Threshold Voltage Vs. Temperature**

Electrical Characteristics Curves (Pre-irradiation)

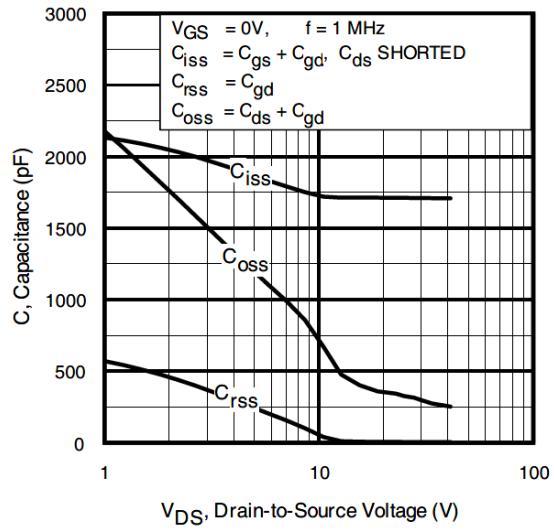


Figure 10 Typical Capacitance Vs. Drain-to-Source Voltage

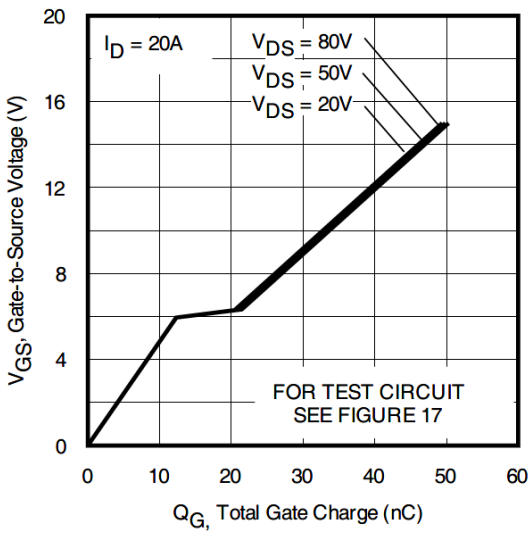


Figure 11 Typical Gate Charge Vs. Typical Gate-to-Source Voltage

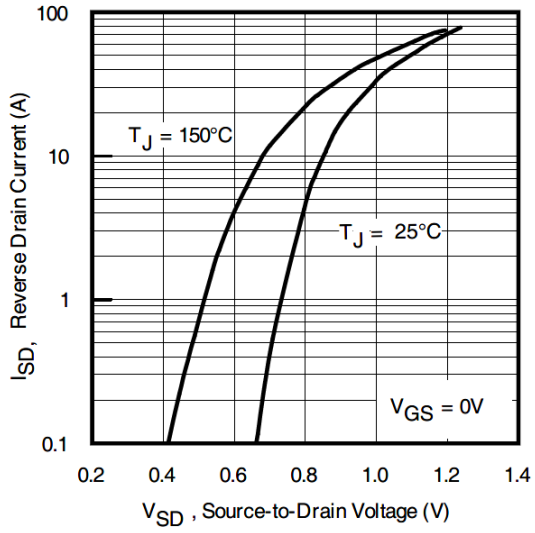


Figure 12 Typical Source-Drain Current Vs. Diode Forward Voltage

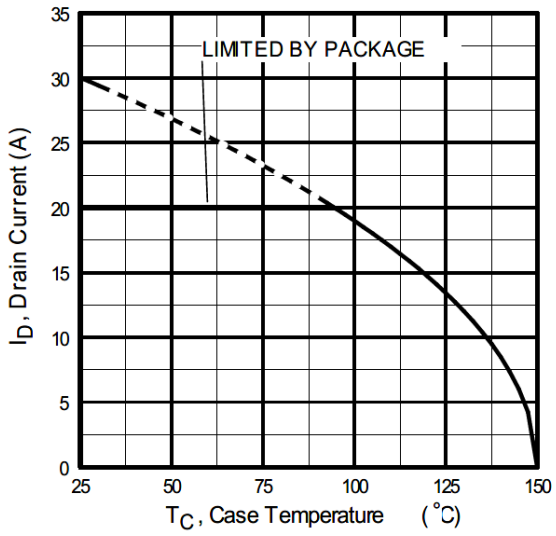


Figure 13 Maximum Drain Current Vs. Case Temperature

Electrical Characteristics Curves (Pre-irradiation)

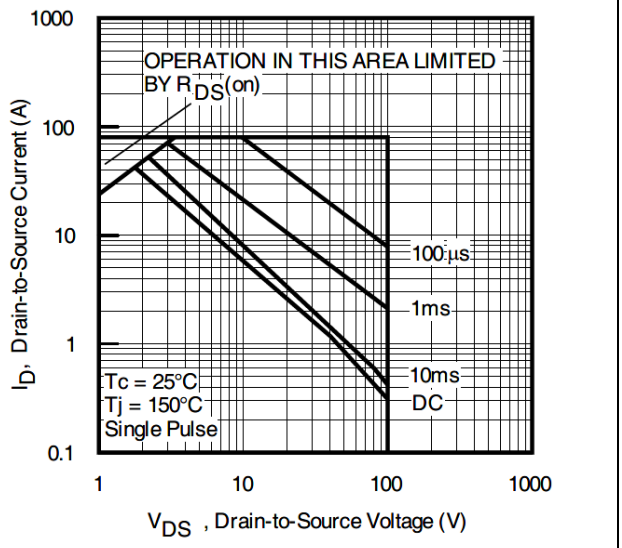


Figure 14 Maximum Safe Operating Area

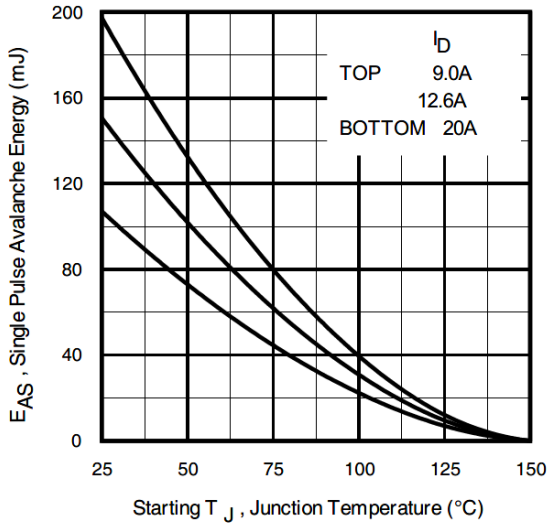


Figure 15 Maximum Avalanche Energy Vs. Junction Temperature

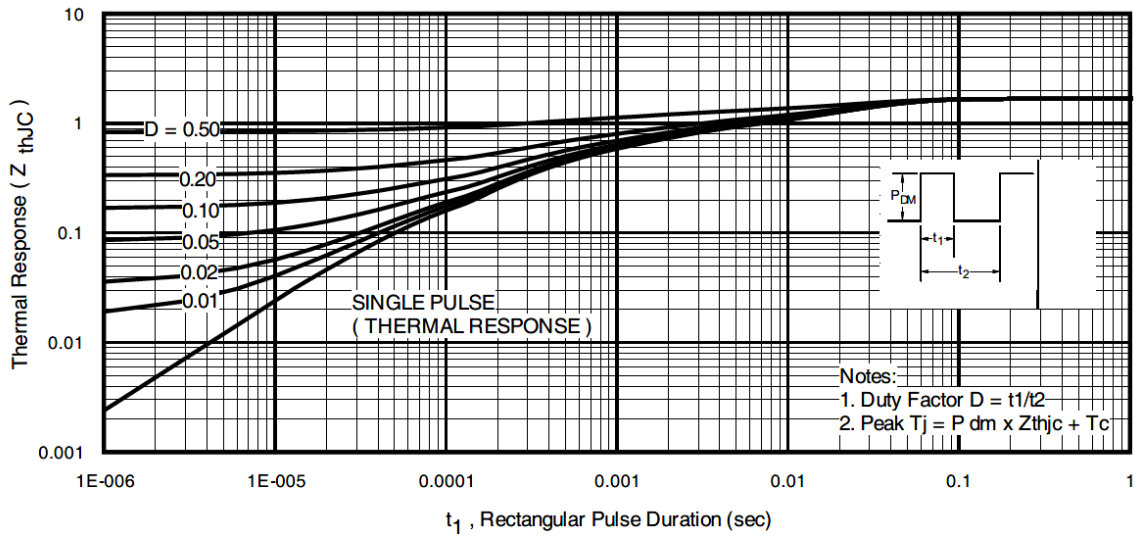


Figure 16 Maximum Effective Transient Thermal Impedance, Junction-to-Case

4 Test Circuits (Pre-irradiation)

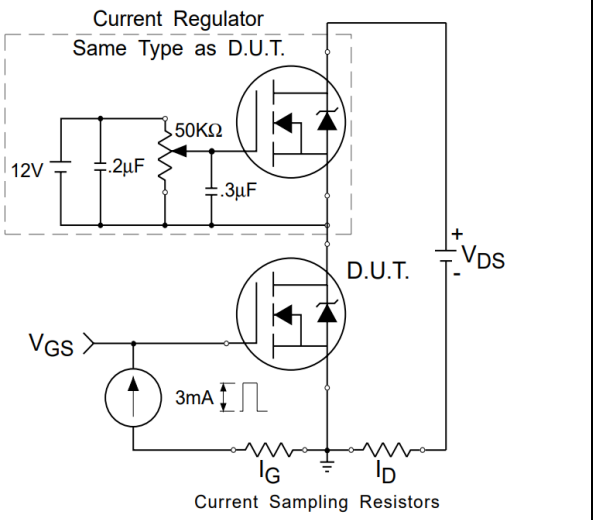


Figure 17 Gate Charge Test Circuit

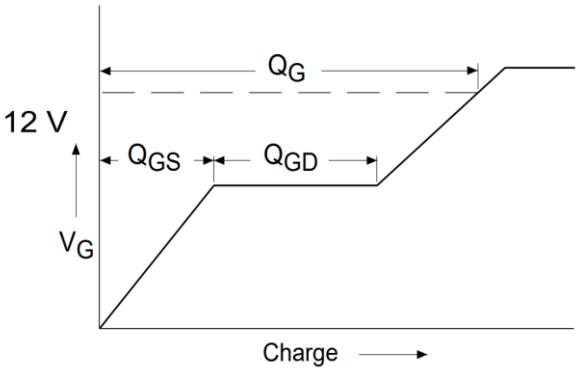


Figure 18 Gate Charge Waveform

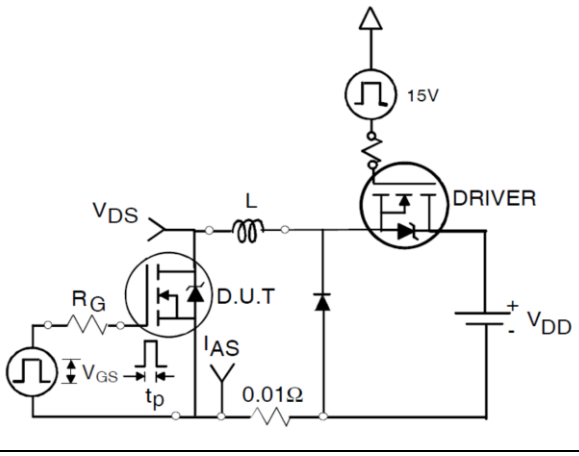


Figure 19 Unclamped Inductive Test Circuit

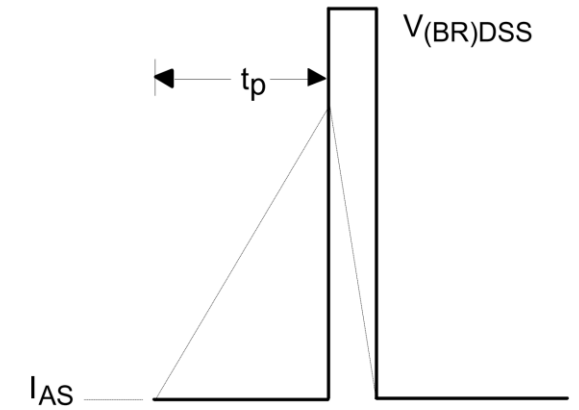


Figure 20 Unclamped Inductive Waveform

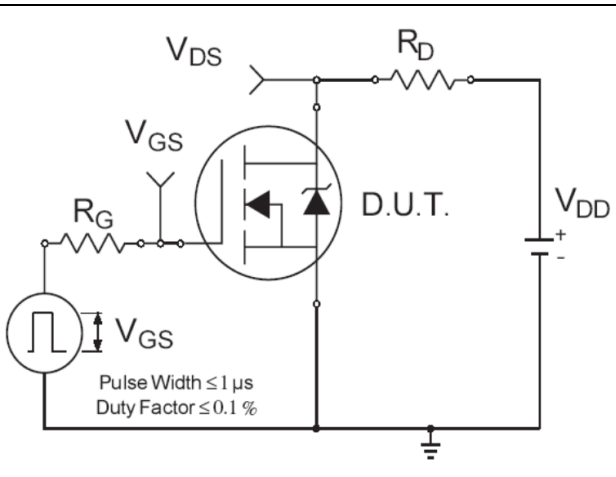


Figure 21 Switching Time Test Circuit

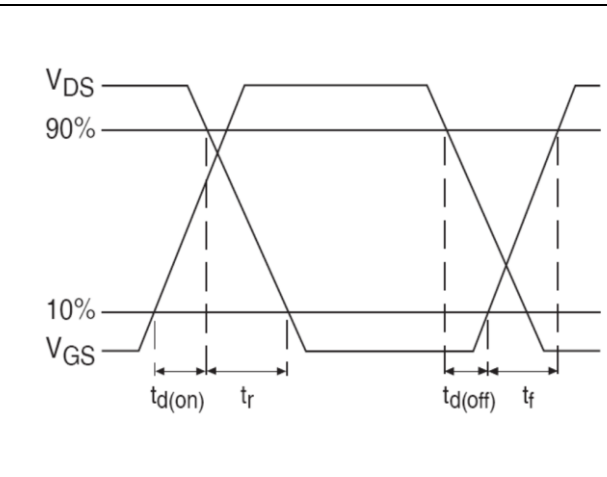
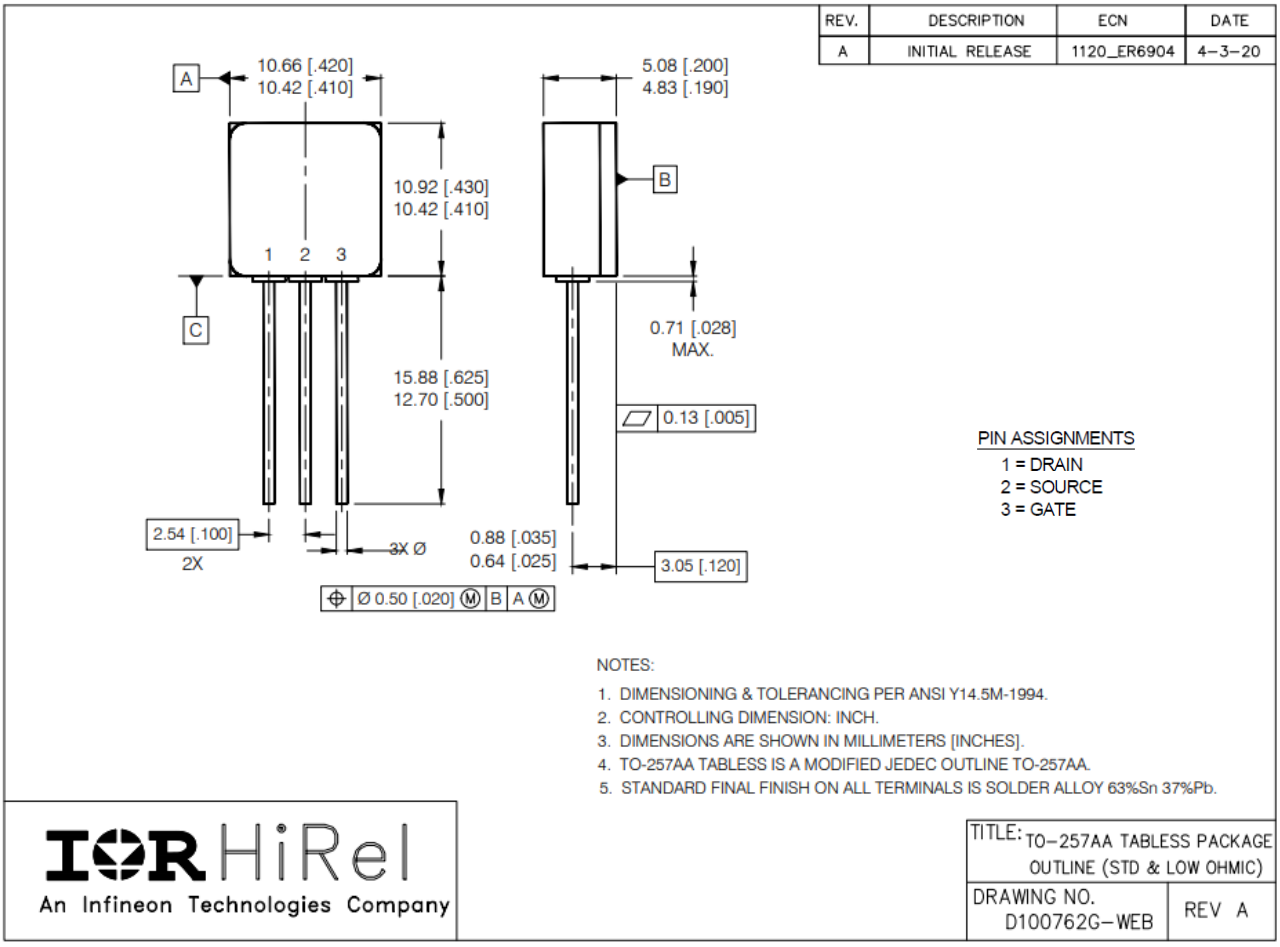


Figure 22 Switching Time Waveforms

5 Package Outline

Note: For the most updated package outline, please see the website: TO-257AA Tabless Low Ohmic



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.

Revision history

Document version	Date of release	Description of changes
	03/25/2004	Datasheet (PD-95841C)
Rev A	11/18/2004	Updated based on ECN-12213
Rev B	06/16/2010	Updated based on ECN-17282
Rev C	12/21/2017	Updated based on ECN-1120_05603
Rev D	05/02/2024	Updated based on ECN-1120_09886

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