

### Features

- Ultra-low  $Q_G$  For High Efficiency
- Logic Level
- Light Weight
- No Wire Bond for Higher Reliability and Low Inductance
- Total Ionizing Dose LDR Immune
- Total Ionizing Dose HDR Immune
- Single Event Effect (SEE) Hardened
  - SEE immunity for LET of 83.2 MeV/(mg/cm<sup>2</sup>) in Si with  $V_{DS}$  up to 100% of rated Breakdown
- Neutron
  - Maintains Pre-Rad specification for up to  $4 \times 10^{15}$  Neutrons/cm<sup>2</sup>



## EPC7014UBSH

**Rad-Hard eGaN® 60 V, 1 A,  
580 mΩ Surface Mount (UB)**

### Description

EPC Space Rad-Hard eGaN® power switching HEMTs have been specifically designed for critical applications in Space and other the high reliability environments. These devices have exceptionally high electron mobility and a low temperature coefficient resulting in very low  $R_{DS(on)}$  values. The lateral structure of the die provides for very low gate charge ( $Q_G$ ) and extremely fast switching times. These features enable faster power supply switching frequencies resulting in higher power densities, higher efficiencies and more compact packaging.

### Application

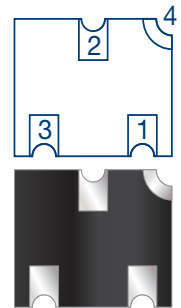
- Commercial Satellite EPS & Avionics
- Deep Space Probes
- High Speed Rad-Hard DC-DC Conversion
- Rad-Hard Motor Controllers
- Nuclear Facilities

### Thermal Characteristics

Symbol	Parameter-Conditions	Value	Units
$R_{\theta JA}$	Thermal Resistance Junction to Ambient (Note 3)	200	°C/W
$R_{\theta JC}$	Thermal Resistance Junction to Case	62.9	

### I/O Pin Assignment (Bottom View)

Pin	Symbol	Description
1	G	Gate
2	D	Drain
3	S	Source
4	L	Lid Pad Connection



### Absolute Maximum Rating ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter-Conditions	Value	Units
$V_{DS}$	Drain to Source Voltage (Note 1)	60	V
	Drain-to-Source Voltage (up to 10,000 5 ms pulses at 150°C)	72	
$I_D$	Continuous Drain Current $I_D$ @ $V_{GS} = 5\text{ V}$ , $T_C = 25^\circ\text{C}$	1	A
$I_{DM}$	Single-Pulse Drain Current $t_{pulse} \leq 80\ \mu\text{s}$	4	
$V_{GS}$	Gate to Source Voltage (Note 2)	+6 / -4	V
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to +150	°C
$T_{sol}$	Package Mounting Surface Temperature	260	
ESD	ESD Class	1A( $\Delta A$ )	
Weight	Device Weight	0.058	g

**Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted. Typical (TYP) values are for reference only.)

Parameter	Symbol	Test Conditions	MIN	TYP	MAX	Units	
Maximum Drain to Source Voltage	$V_{DSMAX}$	$V_{GS} = 0\text{ V}$	60			V	
Drain to Source Leakage	$I_{DSS}$	$V_{DS} = 60\text{ V}$ $V_{GS} = 0\text{ V}$		0.17	100	$\mu\text{A}$	
			$T_C = 25^\circ\text{C}$	0.35	180		
Gate to Source Forward Leakage	$I_{GSSF}$	$V_{GS} = 6\text{ V}$		2	600		
Gate to Source Reverse Leakage	$I_{GSSR}$	$V_{GS} = -3\text{ V}$		0.27	100		
Gate to Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}$ , $I_D = 0.14\text{ mA}$	$T_C = 25^\circ\text{C}$	0.8	1.8	2.5	V
Gate to Source Threshold Voltage Temperature Coefficient	$\Delta V_{GS(th)}/\Delta T$	$V_{DS} = V_{GS}$ , $I_D = 0.14\text{ mA}$	$-55^\circ\text{C} < T_A < 150^\circ\text{C}$	2.34			$\text{mV}/^\circ\text{C}$
Drain to Source Resistance (Note 4)	$R_{DS(on)}$	$I_D = 1\text{ A}$ , $V_{GS} = 5\text{ V}$	$T_C = 25^\circ\text{C}$		340	580	$\text{m}\Omega$
Source to Drain Forward Voltage	$V_{SD}$	$I_S = 0.5\text{ A}$ , $V_G = 0\text{ V}$	$T_C = 25^\circ\text{C}$		2.5	3.5	V

**Dynamic Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted. Typical (TYP) values are for reference only.)

Parameter	Symbol	Test Conditions	MIN	TYP	MAX	Units
Input Capacitance	$C_{ISS}$	$V_{DS} = 30\text{ V}$ , $V_{GS} = 0\text{ V}$		18	28	$\text{pF}$
Output Capacitance	$C_{OSS}$			17	30	
Reverse transfer Capacitance	$C_{RSS}$			0.1	2	
Gate Resistance (Note 5)	$R_G$	$f = 1\text{ MHz}$ , $V_{DS} = V_{GS} = 0\text{ V}$		12.6		$\Omega$
Total Gate Charge (Note 6)	$Q_G$	$V_{DS} = 30\text{ V}$ , $I_D = 0.5\text{ A}$		142	175	$\text{pC}$
Gate to Source Charge (Note 6)	$Q_{GS}$			20	46	
Gate to Drain Charge (Note 6)	$Q_{GD}$			30	40	
Output Charge (Note 5)	$Q_{OSS}$	$V_{GS} = 0\text{ V}$ , $V_{DS} = 30\text{ V}$		764	1145	
Source to Drain Recovery Charge (Note 5)	$Q_{RR}$	$I_D = 1\text{ A}$ , $V_{DS} = 30\text{ V}$		0		

### Radiation Characteristics

EPC Space eGaN® HEMTs are tested according to MIL-STD-750 Method 1019 for total ionizing dose validation. Every manufacturing lot is tested for total ionizing dose of 1 Mrad of Gamma radiation exposure with an in-situ bias for the following conditions:

ON	$V_{GS} = 5\text{ V}$
NO BIAS	$V_{DS} = V_{GS} = 0\text{ V}$
OFF	$V_{DS} = 80\% B_{VDSS}$

**Electrical Characteristics up to 1000 krad ( $T_C = 25^\circ\text{C}$  unless otherwise noted. Typical (TYP) values are for reference only.)**

Parameter	Symbol	Test Conditions	MIN	TYP	MAX	Units
Maximum Drain to Source Voltage	$V_{DSMAX}$	$V_{GS} = 0\text{ V}$	60			V
Gate to Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 0.14\text{ mA}$	0.8	1.8	2.5	
Drain to Source Leakage	$I_{DSS}$	$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$		0.35	100	$\mu\text{A}$
Gate to Source Forward Leakage	$I_{GSSF}$	$V_{GS} = 6\text{ V}$		2	600	
Gate to Source Reverse Leakage	$I_{GSSR}$	$V_{GS} = -3\text{ V}$		0.27	100	
Drain to Source Resistance (Note 4)	$R_{DS(on)}$	$I_D = 1\text{ A}, V_{GS} = 5\text{ V}$		365	580	$\text{m}\Omega$

### Typical Single Event Effect Safe Operating Area

Note: All Radiation Single Event Effects testing are performed in heavy ion environments such as the K-500 Cyclotron at Texas A&M.

Test	Environment				$V_{DS}$ Voltage ( V )	
	Ion	LET MeV(mg/cm <sup>2</sup> ) in Si (+/-5%)	Range $\mu\text{m}$ (+/- 7.5%)	Energy MeV (+/-10%)	$V_{GS} = 0\text{ V}$	$V_{GS} = -4\text{V}$
See SOA	Xe	63.6	71.3	963	60	60
	Au	83.2	121.4	2256	60	60

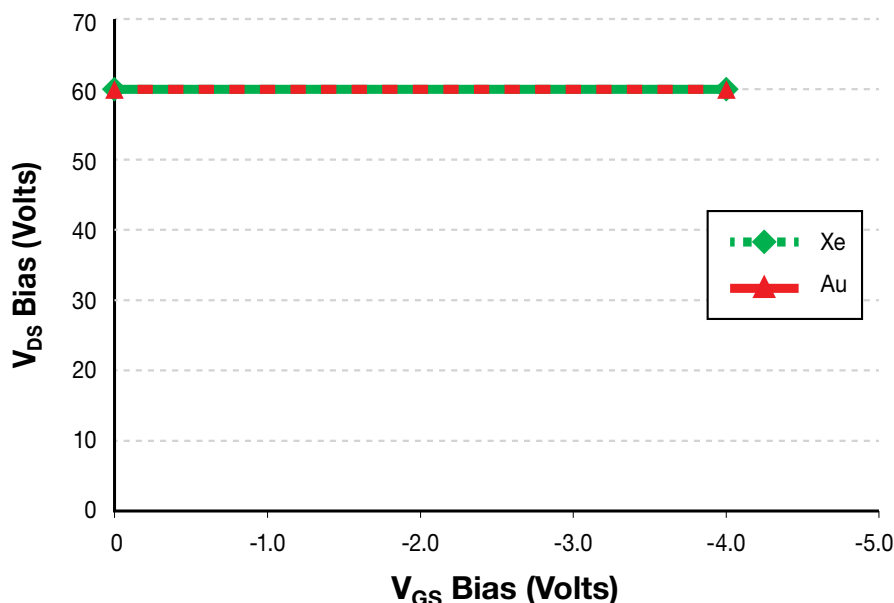


Figure 1. Typical Single Event Effect Safe Operating Area

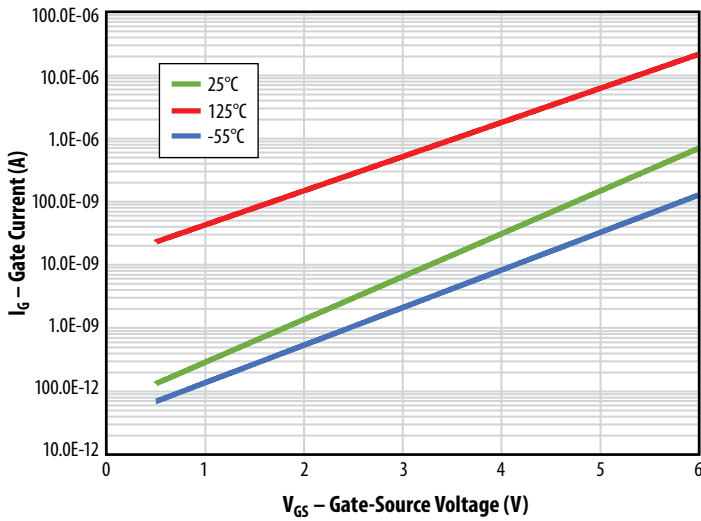


Figure 2. Typical Gate-Source Leakage Current vs. Ambient Temperature

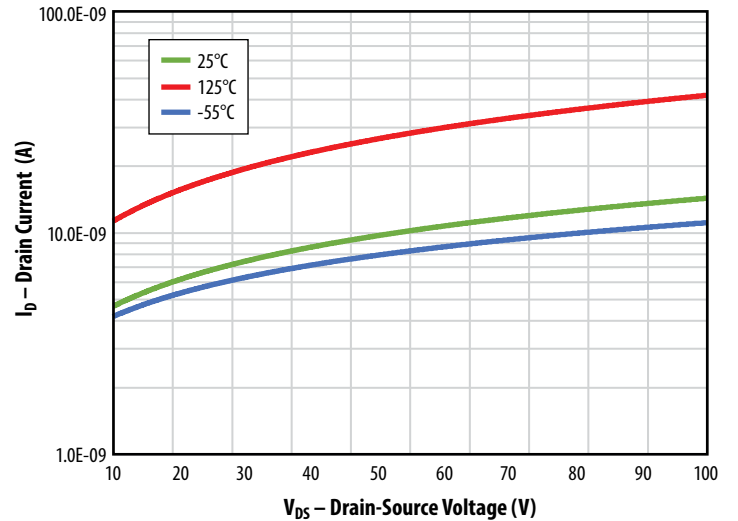


Figure 3: Typical Drain-Source Leakage Current vs. Ambient Temperature

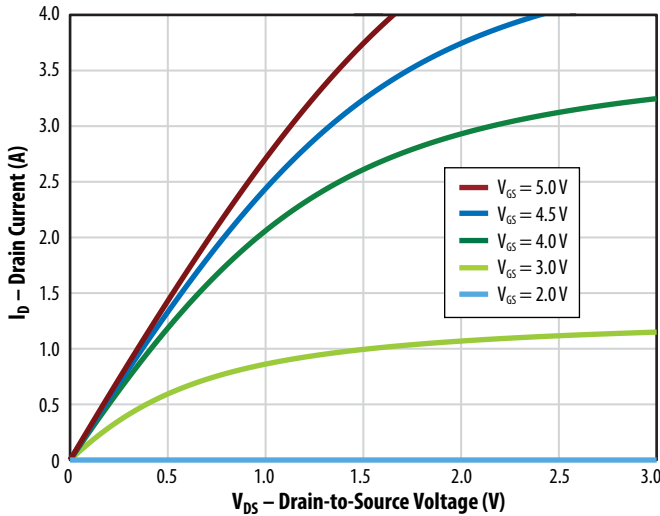


Figure 4. Typical Transfer Characteristics

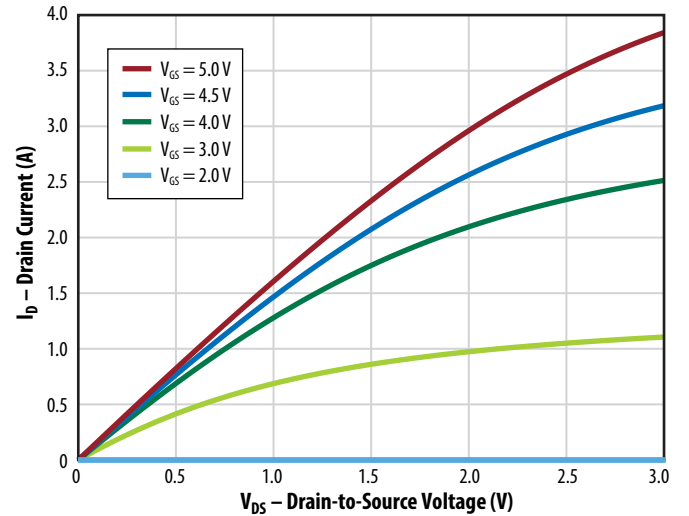


Figure 5. Typical Output Characteristics at 25°C

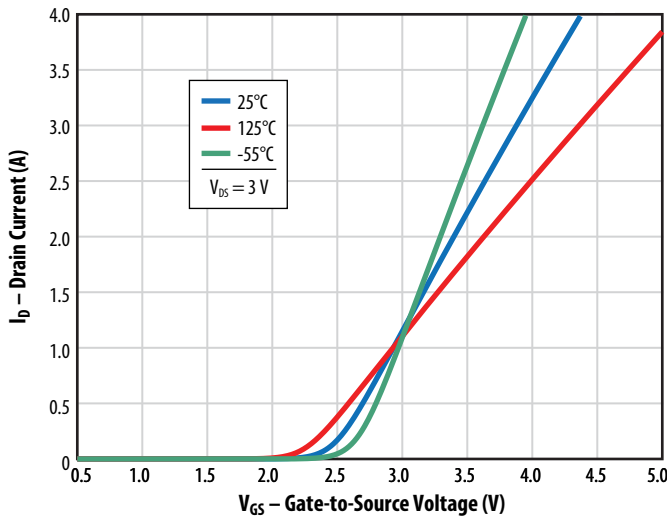


Figure 6. Typical Output Characteristics at 125°C

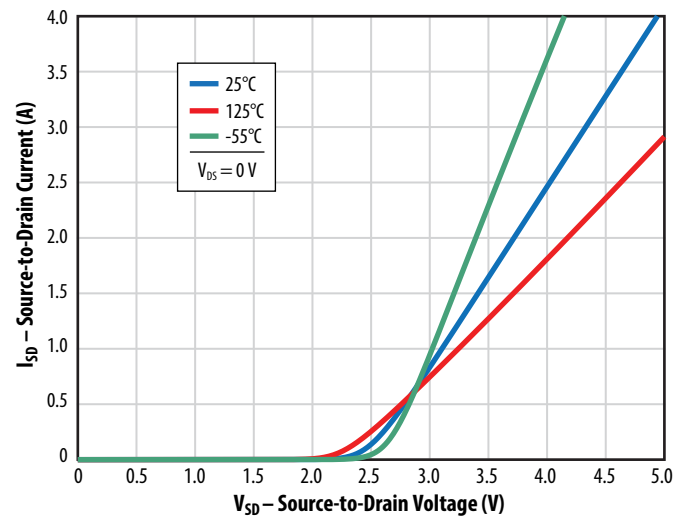


Figure 7. Reverse Drain-Source Characteristics

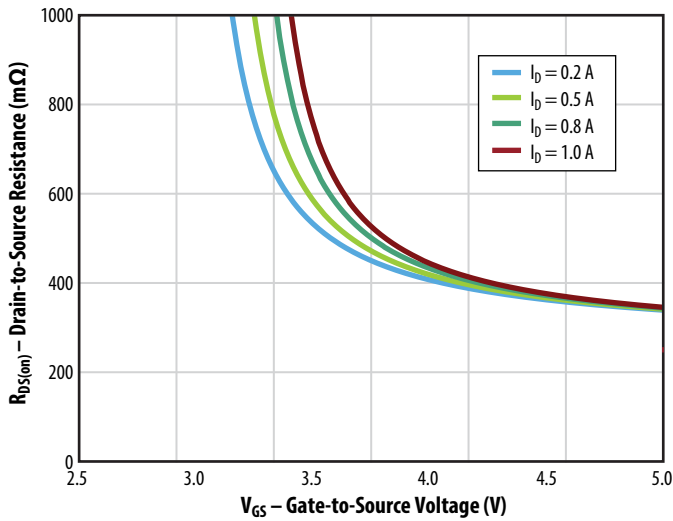


Figure 8.  $R_{DS(on)}$  vs.  $V_{GS}$  for Various Drain Currents

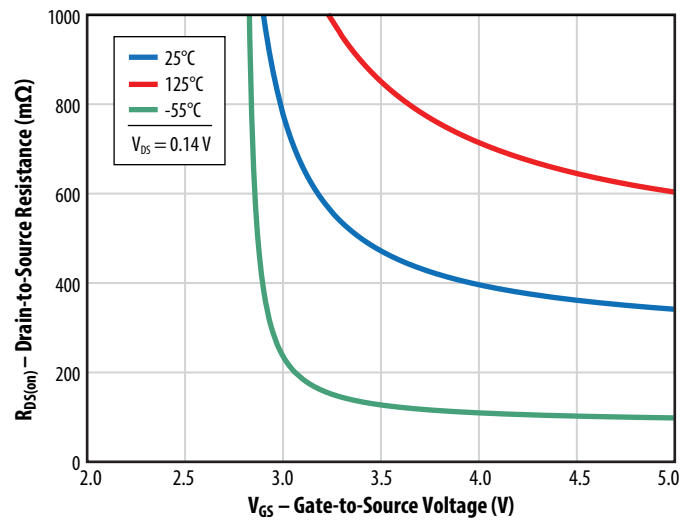


Figure 9.  $R_{DS(on)}$  vs.  $V_{GS}$  for Various Temperatures

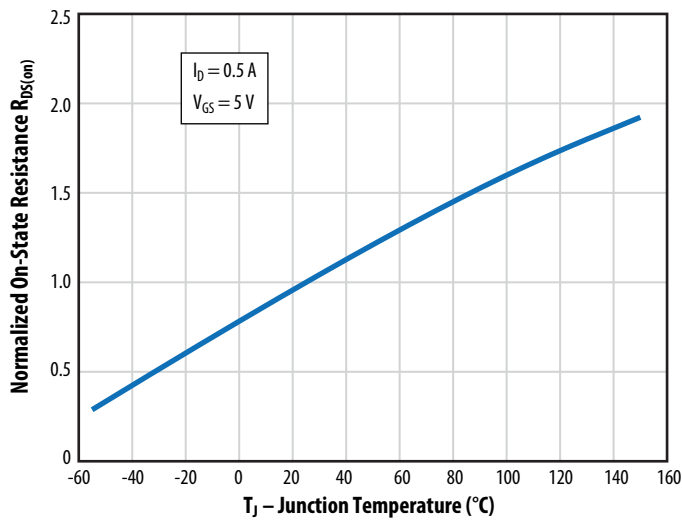


Figure 10. Normalized Threshold Voltage vs. Temperature

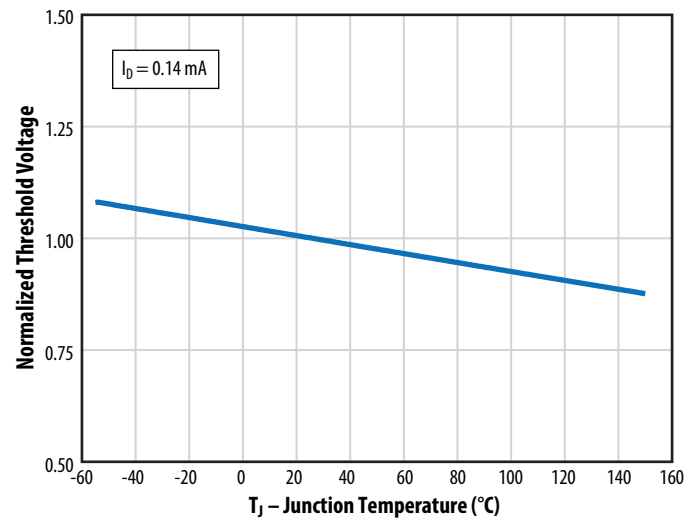


Figure 11. Normalized On-State Resistance vs. Temperature

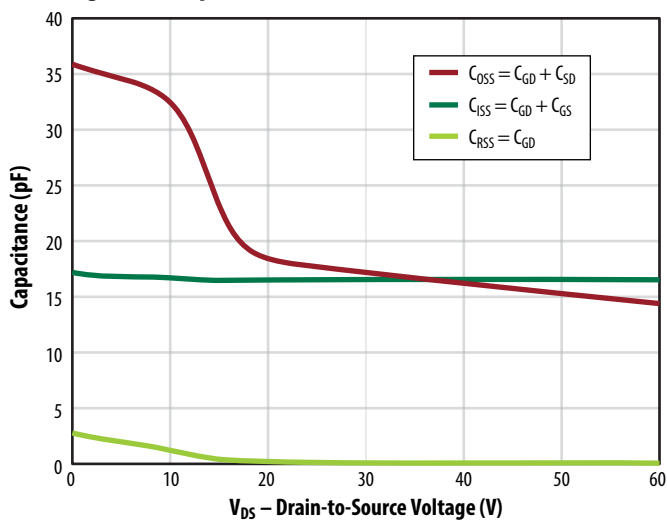


Figure 12. Typical Capacitance

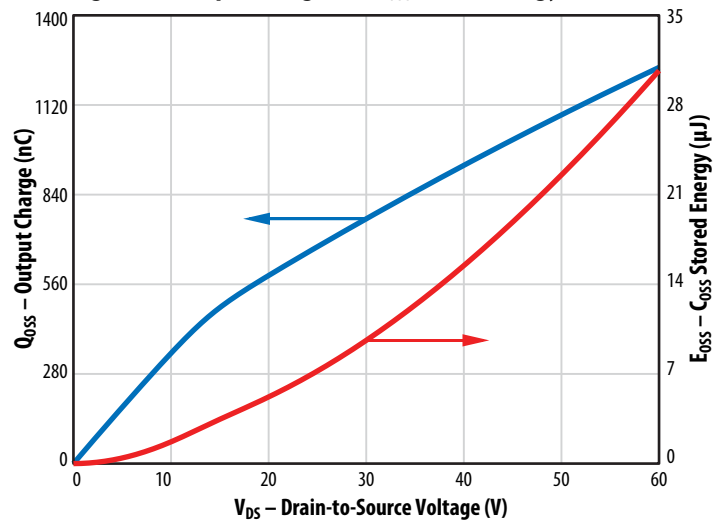


Figure 13. Typical Gate Charge

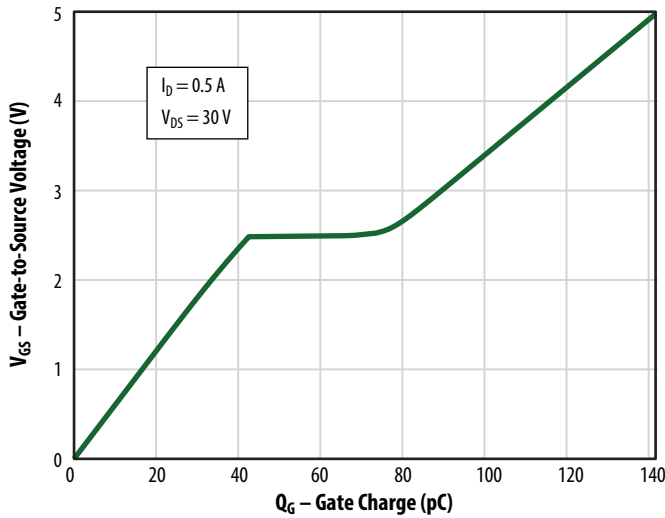


Figure 14. Gate Charge

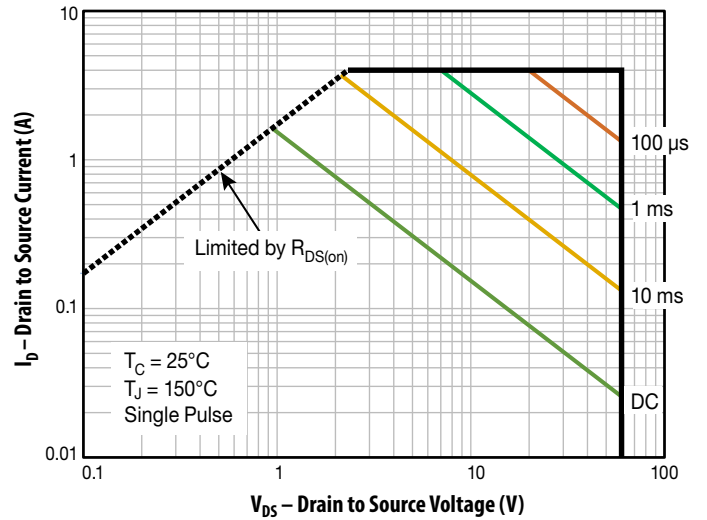


Figure 15. Safe Operating Area

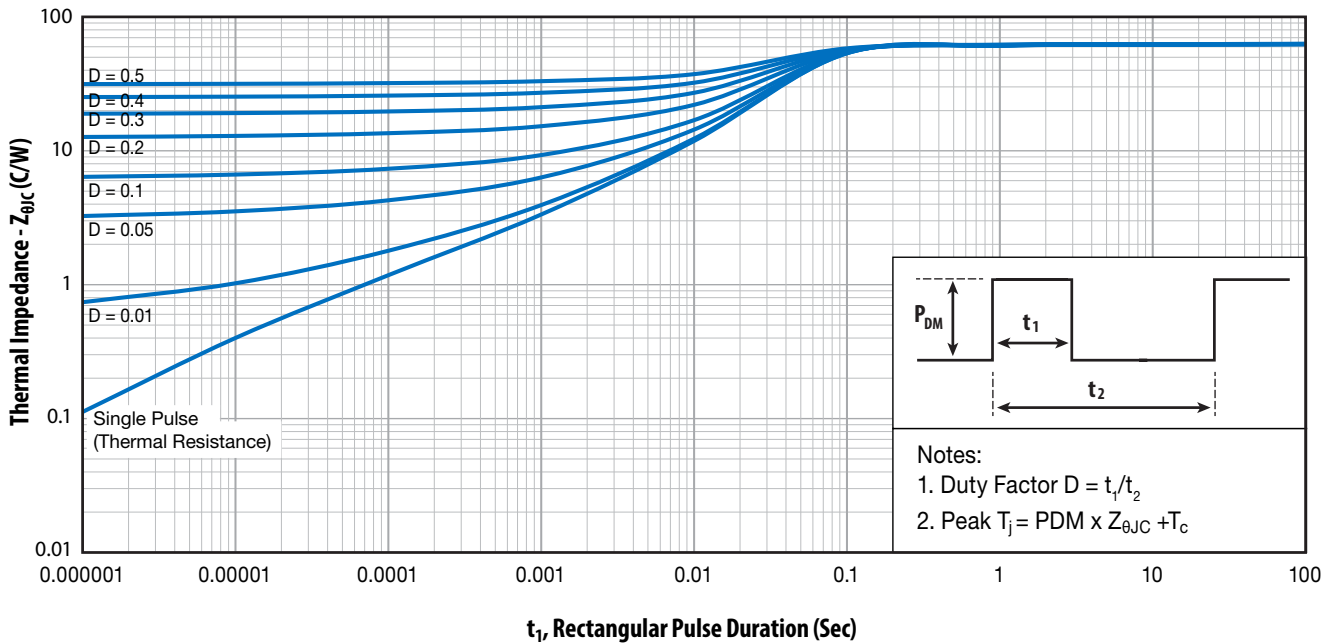
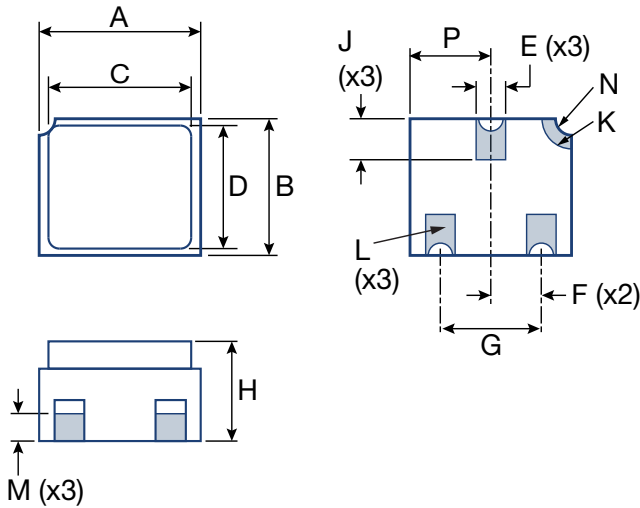


Figure 16. Transient Thermal Impedance, Junction to Case

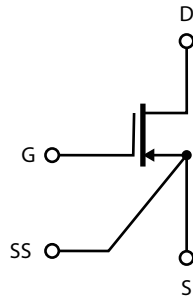
### Package Outline and Dimensions



Symbol	IN			MM		
	MIN	MAX	REF	MIN	MAX	REF
A	0.115	0.127		2.92	3.23	
B	0.095	0.107		2.41	2.72	
C			0.107			2.72
D			0.09			2.29
E	0.016	0.024		0.41	0.61	
F	0.035	0.04		0.89	1.02	
G	0.071	0.079		1.8	2	
H	0.064	0.083		1.63	2.11	
J	0.024	0.036		0.61	0.91	
K			0.022			0.56
L			0.008			0.2
M	0.015	0.025		0.38	0.64	
N			0.012			0.3
P	0.055	0.065		1.4	1.65	

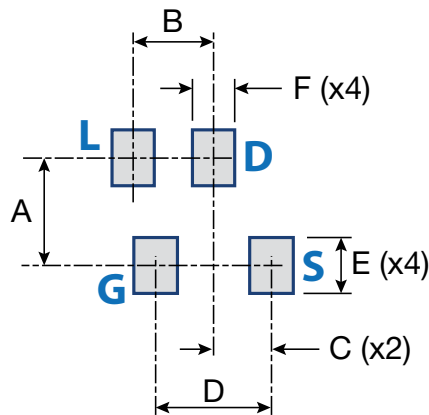
Standard Terminal Pad finish is a solder alloy of 63%Sn 37%Pb

### Package Connections



**NOTE:** SS pin is connected directly to source of internal die.

### UB Footprint for Printed Circuit Board Design



Symbol	IN	MM	Note
	NOM	NOM	
A	0.07	1.78	
B	0.052	1.32	
C	0.038	0.97	
D	0.075	1.91	
E	0.036	0.91	
F	0.028	0.71	

Suggested footprint:  
 NOM. DIM = .003 in [0.08 mm] swell on average

## Notes

- Note 1. Never exceed the absolute maximum  $V_{DS}$  of the device otherwise permanent damage/destruction may result.
- Note 2. Never exceed the absolute maximum  $V_{GS}$  of the device otherwise permanent damage/destruction may result. We recommend a  $V_{GS}$  of 5V for optimum operation across life and radiation.
- Note 3.  $R_{\theta JA}$  measured with LCC3 package mounted to double-sided PCB, 0.063" thickness with 1.0 square inches of copper area on the top (mounting side) and a flood etch (3 square inches) on the bottom side.
- Note 4. Measured using four wire (Kelvin) sensing and pulse measurement techniques. Measurement pulse width is 80  $\mu s$  and duty cycle is 1%, maximum.
- Note 5. Guaranteed by design/device construction. Not tested.
- Note 6. The gate charge parameters are measured based on the MIL-STD-750.3471 Condition B. A high speed constant gate current ( $I_{const}$ ) is provided to the Gate of the DUT during the time that the ground switch ( $G_S$ ) is OFF ( $t_{off}$ ). The DUT is switched ON and OFF using ground-sensed switch  $G_S$ . The gate current is adjusted to yield the desired charge per unit time ( $I_{const} \cdot \text{time per division}$ ) on the measuring oscilloscope. The  $G_S$  pulse drive ON time ( $t_{on}$ ) is adjusted for the desired observability of the gate-source voltage ( $V_{GS}$ ) waveform. The maximum duty cycle of the ground switch ( $t_{off}/t_{on}$ ) should be set to 1% maximum. Please note that all gate-related signals are referenced to the "Source Sense" pin on the package. At all times during the measurement, the maximum gate-source voltage is clamped to 5  $V_{DC}$ .

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