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# FDZ391P

## P-Channel 1.5 V PowerTrench® Thin WL-CSP MOSFET

-20 V, -3 A, 85 mΩ

### Features

- Max  $r_{DS(on)}$  = 85 mΩ at  $V_{GS} = -4.5$  V,  $I_D = -1$  A
- Max  $r_{DS(on)}$  = 123 mΩ at  $V_{GS} = -2.5$  V,  $I_D = -1$  A
- Max  $r_{DS(on)}$  = 200 mΩ at  $V_{GS} = -1.5$  V,  $I_D = -1$  A
- Occupies only 1.5 mm<sup>2</sup> of PCB area
- **Ultra-thin package:** less than 0.4 mm height when mounted to PCB
- RoHS Compliant

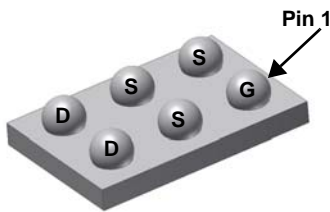


### General Description

Designed on Fairchild's advanced 1.5 V PowerTrench process with state of the art "low pitch" Thin WLCSP packaging process, the FDZ391P minimizes both PCB space and  $r_{DS(on)}$ . This advanced WLCSP MOSFET embodies a breakthrough in packaging technology which enables the device to combine excellent thermal transfer characteristics, ultra-low profile packaging, low gate charge, and low  $r_{DS(on)}$ .

### Applications

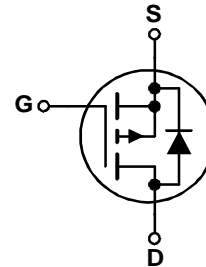
- Battery management
- Load switch
- Battery protection



BOTTOM



TOP



### MOSFET Maximum Ratings $T_A = 25$ °C unless otherwise noted

Symbol	Parameter	Rated	Units
$V_{DS}$	Drain to Source Voltage	-20	V
$V_{GS}$	Gate to Source Voltage	±8	V
$I_D$	Drain Current -Continuous $T_A = 25$ °C (Note 1a)	-3	A
	-Pulsed	-15	
$P_D$	Power Dissipation $T_A = 25$ °C (Note 1a)	1.9	W
	Power Dissipation $T_A = 25$ °C (Note 1b)	0.9	
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to +150	°C

### Thermal Characteristics

$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1a)	65	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1b)	133	

### Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
6	FDZ391P	WL-CSP Thin	7"	8 mm	5000 units

## Electrical Characteristics $T_J = 25\text{ }^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
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### Off Characteristics

$BV_{DSS}$	Drain to Source Breakdown Voltage	$I_D = -250\ \mu\text{A}$ , $V_{GS} = 0\ \text{V}$	-20			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = -250\ \mu\text{A}$ , referenced to $25\text{ }^\circ\text{C}$		-12		mV/ $^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = -16\ \text{V}$ , $V_{GS} = 0\ \text{V}$			-1	$\mu\text{A}$
$I_{GSS}$	Gate to Source Leakage Current	$V_{GS} = \pm 8\ \text{V}$ , $V_{DS} = 0\ \text{V}$			$\pm 100$	nA

### On Characteristics

$V_{GS(th)}$	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}$ , $I_D = -250\ \mu\text{A}$	-0.4	-0.6	-1.5	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate to Source Threshold Voltage Temperature Coefficient	$I_D = -250\ \mu\text{A}$ , referenced to $25\text{ }^\circ\text{C}$		2		mV/ $^\circ\text{C}$
$r_{DS(on)}$	Drain to Source On Resistance	$V_{GS} = -4.5\ \text{V}$ , $I_D = -1\ \text{A}$		74	85	m $\Omega$
		$V_{GS} = -2.5\ \text{V}$ , $I_D = -1\ \text{A}$		90	123	
		$V_{GS} = -1.5\ \text{V}$ , $I_D = -1\ \text{A}$		140	200	
		$V_{GS} = -4.5\ \text{V}$ , $I_D = -1\ \text{A}$ , $T_J = 125\text{ }^\circ\text{C}$		100	123	
$I_{D(on)}$	On to State Drain Current	$V_{GS} = -4.5\ \text{V}$ , $V_{DS} = -5\ \text{V}$	-10			A
$g_{FS}$	Forward Transconductance	$V_{DS} = -5\ \text{V}$ , $I_D = -1\ \text{A}$		7		S

### Dynamic Characteristics

$C_{iss}$	Input Capacitance	$V_{DS} = -10\ \text{V}$ , $V_{GS} = 0\ \text{V}$ , $f = 1\ \text{MHz}$		800	1065	pF
$C_{oss}$	Output Capacitance			155	205	pF
$C_{rss}$	Reverse Transfer Capacitance			90	135	pF
$R_g$	Gate Resistance		$f = 1\ \text{MHz}$		9	

### Switching Characteristics

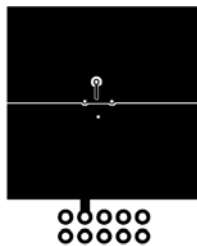
$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = -10\ \text{V}$ , $I_D = -1\ \text{A}$ $V_{GS} = -4.5\ \text{V}$ , $R_{GEN} = 6\ \Omega$		11	20	ns
$t_r$	Rise Time			10	20	ns
$t_{d(off)}$	Turn-Off Delay Time			50	80	ns
$t_f$	Fall Time			30	48	ns
$Q_g$	Total Gate Charge		$V_{GS} = -4.5\ \text{V}$		9	13
$Q_{gs}$	Gate to Source Gate Charge	$V_{DD} = -10\ \text{V}$		1		nC
$Q_{gd}$	Gate to Drain "Miller" Charge	$I_D = -1\ \text{A}$		2		nC

### Drain-Source Diode Characteristics

$I_S$	Maximum continuous Drain-Source Diode Forward Current				-1.1	A
$V_{SD}$	Source to Drain Diode Forward Voltage	$V_{GS} = 0\ \text{V}$ , $I_S = -1.1\ \text{A}$ (Note 2)		-0.7	-1.2	V
$t_{rr}$	Reverse Recovery Time	$I_F = -1\ \text{A}$ , $di/dt = 100\ \text{A}/\mu\text{s}$		21		ns
$Q_{rr}$	Reverse Recovery Charge			5		nC

#### Notes:

1.  $R_{\theta JA}$  is determined with the device mounted on a 1 in<sup>2</sup> pad 2 oz copper pad on a 1.5 x 1.5 in. board of FR-4 material.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a.  $65\text{ }^\circ\text{C}/\text{W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper.



b.  $133\text{ }^\circ\text{C}/\text{W}$  when mounted on a minimum pad of 2 oz copper.

2. Pulse Test: Pulse Width < 300 $\mu\text{s}$ , Duty cycle < 2.0%.

**Typical Characteristics**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted

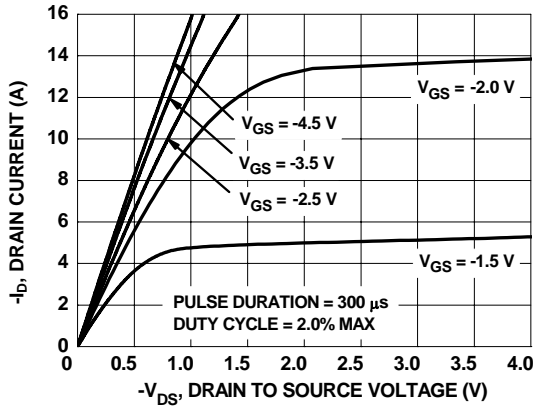


Figure 1. On Region Characteristics

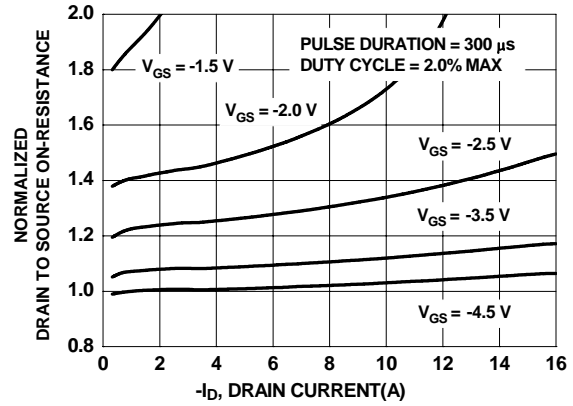


Figure 2. Normalized On-Resistance vs Drain Current and Gate Voltage

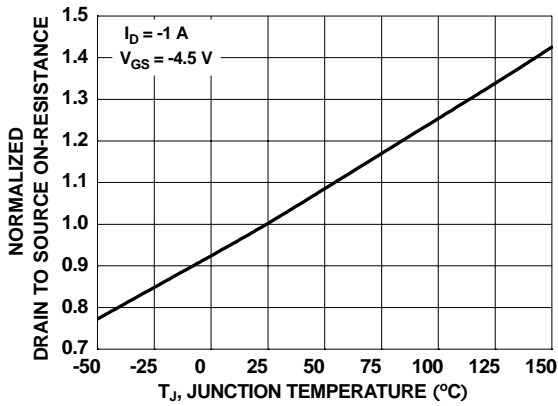


Figure 3. Normalized On Resistance vs Junction Temperature

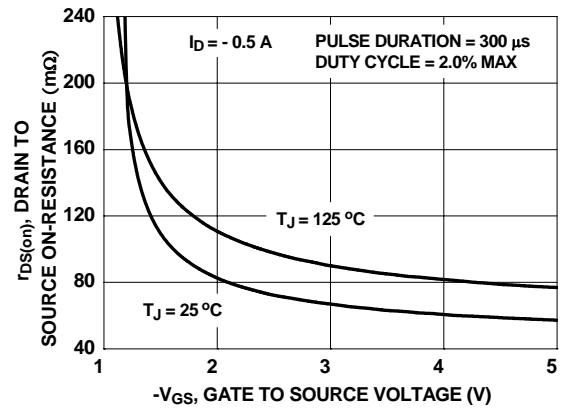


Figure 4. On-Resistance vs Gate to Source Voltage

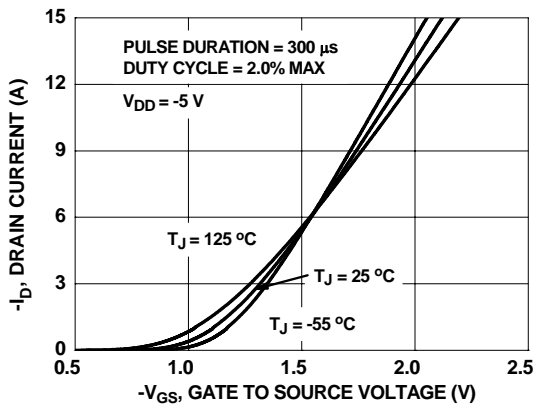


Figure 5. Transfer Characteristics

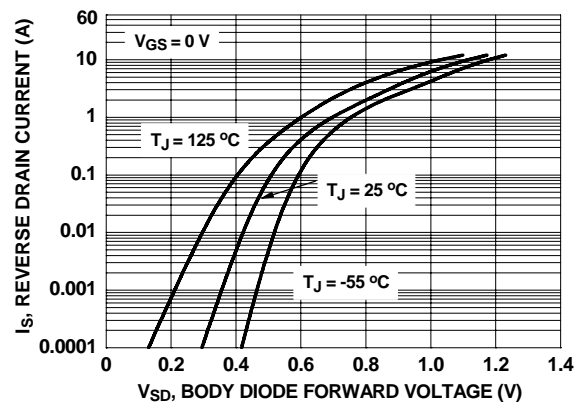
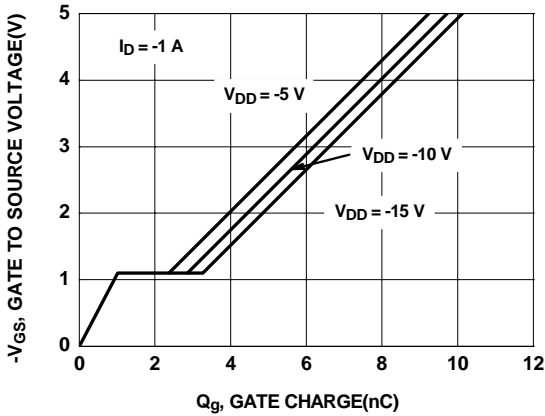
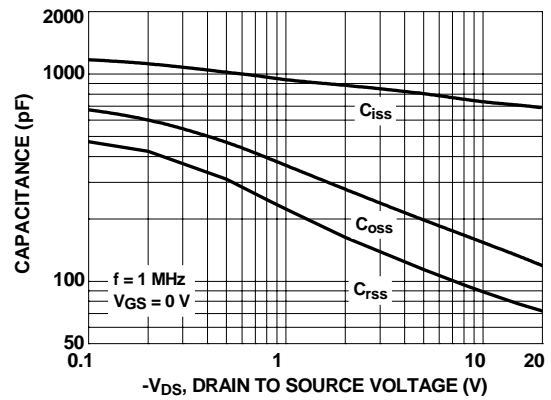


Figure 6. Source to Drain Diode Forward Voltage vs Source Current

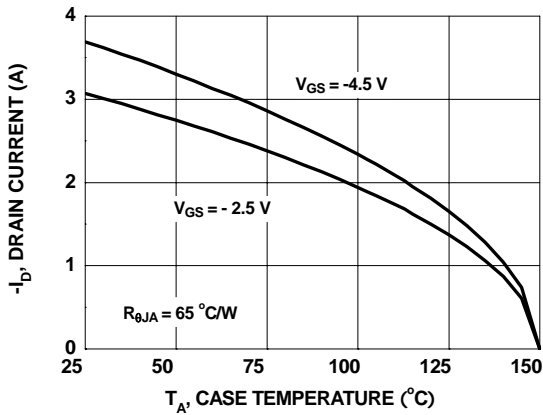
**Typical Characteristics**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted



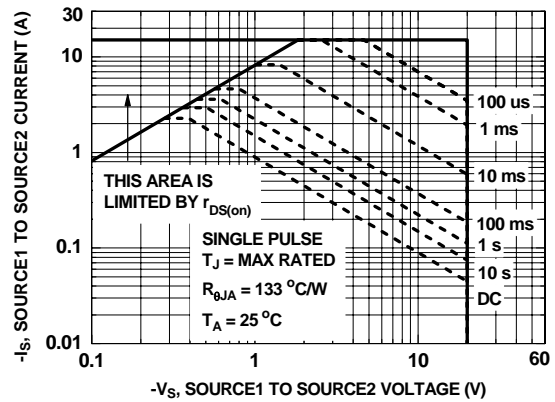
**Figure 7. Gate Charge Characteristics**



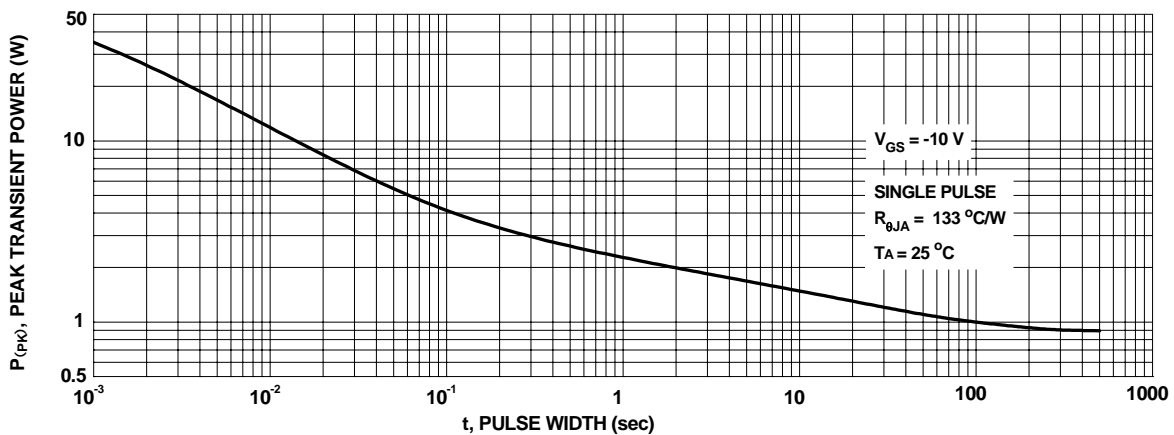
**Figure 8. Capacitance vs Drain to Source Voltage**



**Figure 9. Maximum Continuous Drain Current vs Ambient Temperature**

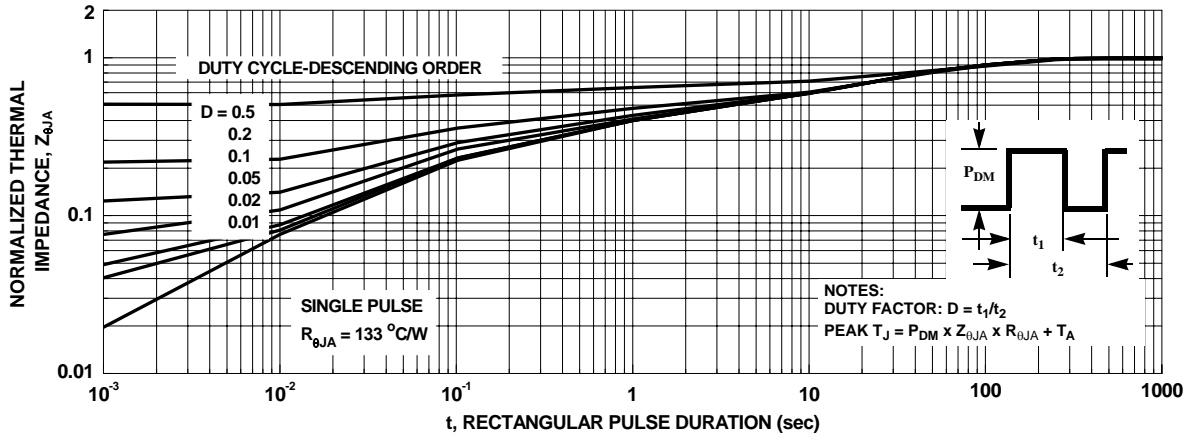


**Figure 10. Forward Bias Safe Operating Area**



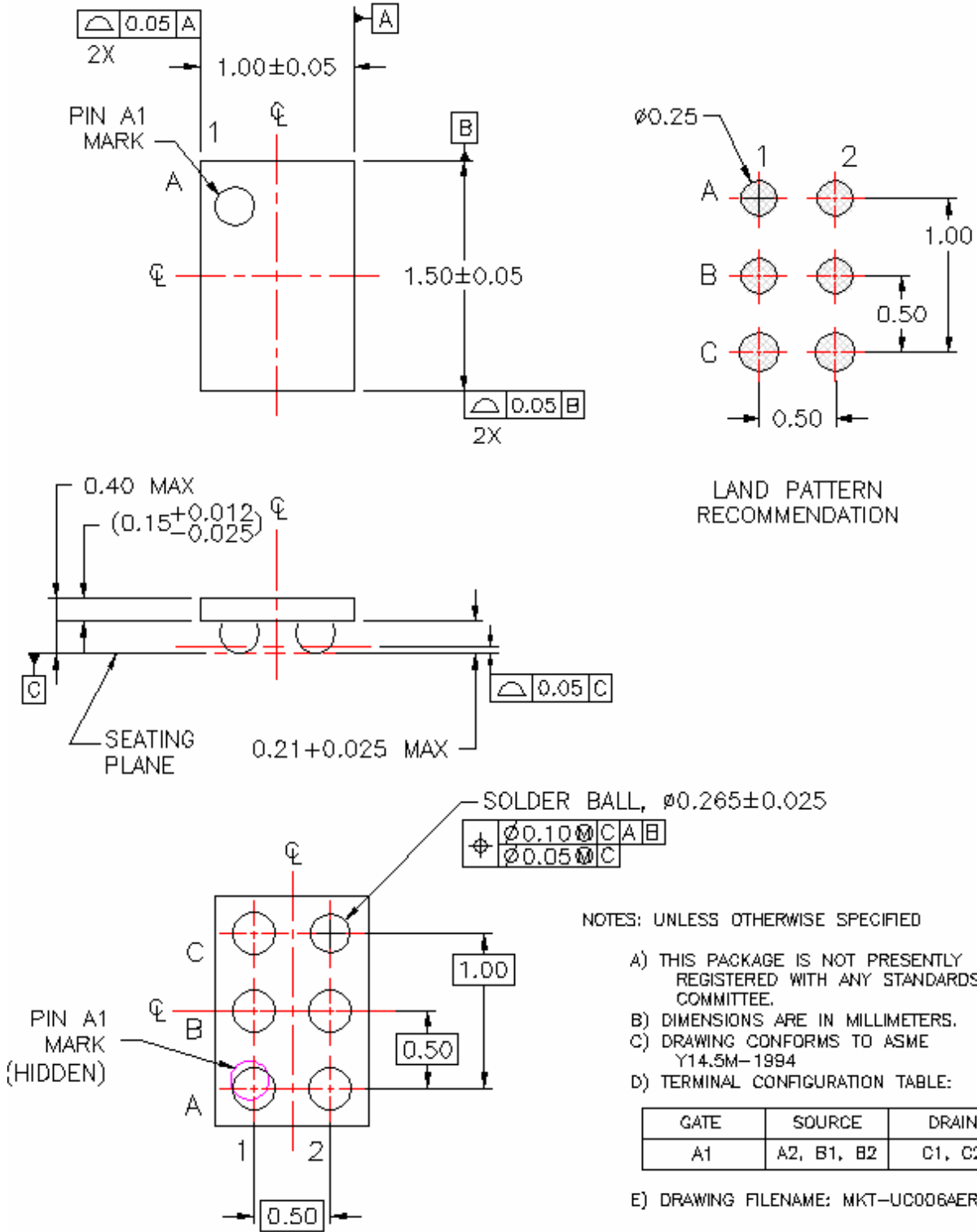
**Figure 11. Single Pulse Maximum Power Dissipation**

**Typical Characteristics**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted



**Figure 12. Transient Thermal Response Curve**







### Dimensional Outline and Pad Layout





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