

# FDS6993

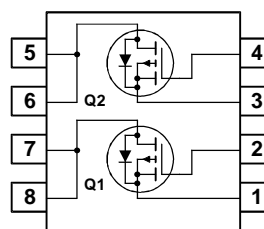
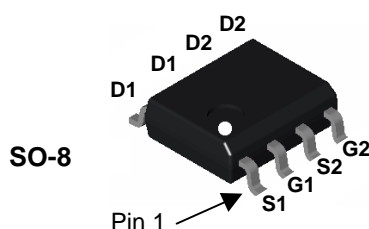
## Dual P-Channel PowerTrench<sup>®</sup> MOSFET

### General Description

These P-Channel MOSFETs are made using FSC's **PowerTrench<sup>®</sup>** technology. They are packaged in a single SO-8 which is designed to allow two MOSFETs to operate independently, each with its own heat sink. The combination of silicon and package technologies results in minimum board space and cost.

### Features

- **Q1:** P-Channel  
 $-4.3A, -30V R_{DS(on)} = 55m\Omega @ V_{GS} = -10V$   
 $R_{DS(on)} = 85m\Omega @ V_{GS} = -4.5V$
- **Q2:** P-Channel  
 $-6.8A, -12V R_{DS(on)} = 17m\Omega @ V_{GS} = -4.5V$   
 $R_{DS(on)} = 24m\Omega @ V_{GS} = -2.5V$   
 $R_{DS(on)} = 30m\Omega @ V_{GS} = -1.8V$
- High power and handling capability in a widely used surface mount package



### Absolute Maximum Ratings $T_A = 25^\circ C$ unless otherwise noted

Symbol	Parameter	Q1	Q2	Units
$V_{DSS}$	Drain-Source Voltage	-30	-12	V
$V_{GSS}$	Gate-Source Voltage	$\pm 25$	$\pm 8$	V
$I_D$	Drain Current - Continuous (Note 1a)	-4.3	-6.8	A
	- Pulsed	-20	-20	
$P_D$	Power Dissipation for Dual Operation	2		W
	Power Dissipation for Single Operation (Note 1a)	1.6		
	(Note 1b)	1		
	(Note 1c)	0.9		
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to +150		$^\circ C$

### Thermal Characteristics

$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (Note 1a)	78	$^\circ C/W$
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case (Note 1)	40	$^\circ C/W$

### Package Marking and Ordering Information

Device Marking	Device	Reel Size	Tape width	Quantity
FDS6993	FDS6993	13"	12mm	2500 units

### Electrical Characteristics

$T_A = 25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Type	Min	Typ	Max	Units
<b>Off Characteristics</b>							
$BV_{DSS}$	Drain-Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_D = -250\ \mu\text{A}$ $V_{GS} = 0\text{ V}, I_D = -250\ \mu\text{A}$	Q1 Q2	-30 -12			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = -250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$ $I_D = -250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$	Q1 Q2		-21 -0.9		mV/ $^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = -24\text{ V}, V_{GS} = 0\text{ V}$ $V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V}$	Q1 Q2			-1 -1	$\mu\text{A}$
$I_{GSS}$	Gate-Body Leakage	$V_{GS} = \pm 25\text{ V}, V_{DS} = 0\text{ V}$ $V_{GS} = \pm 8\text{ V}, V_{DS} = 0\text{ V}$	Q1 Q2			$\pm 100$ $\pm 100$	nA
<b>On Characteristics (Note 2)</b>							
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = -250\ \mu\text{A}$ $V_{DS} = V_{GS}, I_D = -250\ \mu\text{A}$	Q1 Q2	-1 -0.4	-1.8 -0.5	-3 -1.5	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate Threshold Voltage Temperature Coefficient	$I_D = -250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$ $I_D = -250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$	Q1 Q2		4 3		mV/ $^\circ\text{C}$
$R_{DS(on)}$	Static Drain-Source On-Resistance	$V_{GS} = -10\text{ V}, I_D = -4.3\text{ A}$ $V_{GS} = -10\text{ V}, I_D = -4.3\text{ A}, T_J = 125^\circ\text{C}$ $V_{GS} = -4.5\text{ V}, I_D = -3.4\text{ A}$  $V_{GS} = -4.5\text{ V}, I_D = -6.8\text{ A}$ $V_{GS} = -4.5\text{ V}, I_D = -6.8\text{ A}, T_J = 125^\circ\text{C}$ $V_{GS} = -2.5\text{ V}, I_D = -5.9\text{ A}$ $V_{GS} = -1.8\text{ V}, I_D = -5.0\text{ A}$	Q1  Q2		48 64 74  11 14 14 19	55 80 85  17 24 24 30	m $\Omega$
$I_{D(on)}$	On-State Drain Current	$V_{GS} = -10\text{ V}, V_{DS} = -5\text{ V}$ $V_{GS} = -4.5\text{ V}, V_{DS} = -5\text{ V}$	Q1 Q2	-20 -20			A
$g_{FS}$	Forward Transconductance	$V_{DS} = -10\text{ V}, I_D = -7\text{ A}$ $V_{DS} = -5\text{ V}, I_D = -5\text{ A}$	Q1 Q2		9 34		S
<b>Dynamic Characteristics</b>							
$C_{iss}$	Input Capacitance	Q1 $V_{DS} = -15\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$	Q1 Q2		530 2980		pF
$C_{oss}$	Output Capacitance	Q2	Q1 Q2		140 1230		pF
$C_{rss}$	Reverse Transfer Capacitance	$V_{DS} = -6\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$	Q1 Q2		70 790		pF

**Electrical Characteristics (continued)**  $T_A = 25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Type	Min	Typ	Max	Units
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**Switching Characteristics** (Note 2)

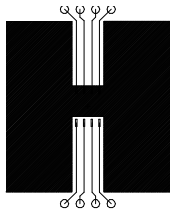
$t_{d(on)}$	Turn-On Delay Time	Q1 $V_{DD} = -15\text{ V}, I_D = -1\text{ A},$	Q1		10	19	ns
		$V_{GS} = -10\text{ V}, R_{GEN} = 6\ \Omega$	Q2		19	34	
$t_r$	Turn-On Rise Time		Q1		14	26	ns
			Q2		20	35	
$t_{d(off)}$	Turn-Off Delay Time	Q2 $V_{DD} = -6\text{ V}, I_D = -1\text{ A},$	Q1		14	24	ns
		$V_{GS} = -4.5\text{ V}, R_{GEN} = 6\ \Omega$	Q2		134	215	
$t_f$	Turn-Off Fall Time		Q1		9	18	ns
			Q2		121	193	
$Q_g$	Total Gate Charge	Q1 $V_{DS} = -15\text{ V}, I_D = -4.3\text{ A},$	Q1		5.5	7.7	nC
		$V_{GS} = -5\text{ V}$	Q2		32	45	
$Q_{gs}$	Gate-Source Charge		Q1		1.8		nC
			Q2		4.0		
$Q_{gd}$	Gate-Drain Charge	$V_{DS} = -6\text{ V}, I_D = -6.8\text{ A},$	Q1		2.2		nC
		$V_{GS} = -5\text{ V}$	Q2		8.0		

**Drain-Source Diode Characteristics and Maximum Ratings**

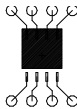
$I_S$	Maximum Continuous Drain-Source Diode Forward Current		Q1			-1.3	A
			Q2			-1.3	
$V_{SD}$	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = -1.3\text{ A}$ (Note 2)	Q1		-0.8	-1.2	V
		$V_{GS} = 0\text{ V}, I_S = -1.3\text{ A}$ (Note 2)	Q2		-0.6	-1.2	

**Notes:**

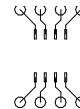
1.  $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a)  $78^\circ\text{W}$  when mounted on a  $0.5\text{ in}^2$  pad of 2 oz copper



b)  $125^\circ\text{W}$  when mounted on a  $.02\text{ in}^2$  pad of 2 oz copper



c)  $135^\circ\text{W}$  when mounted on a minimum pad.

Scale 1 : 1 on letter size paper

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

Typical Characteristics: Q1

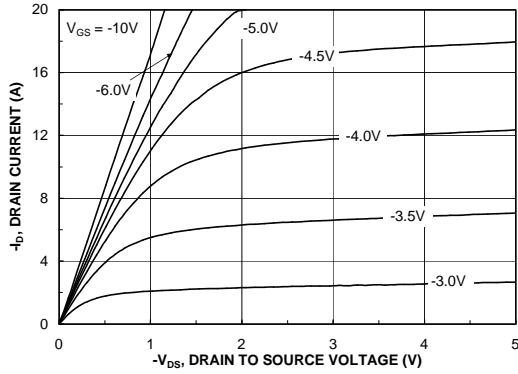


Figure 1. On-Region Characteristics.

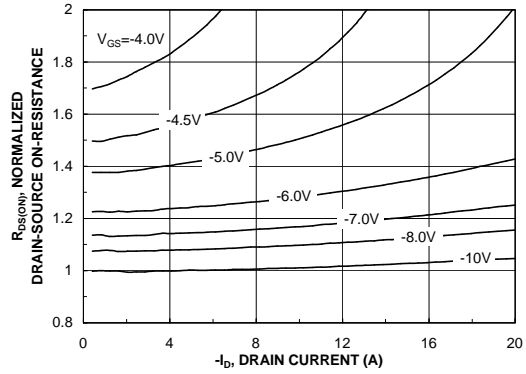


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.

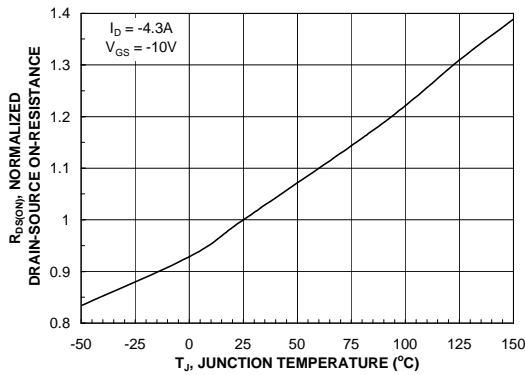


Figure 3. On-Resistance Variation with Temperature.

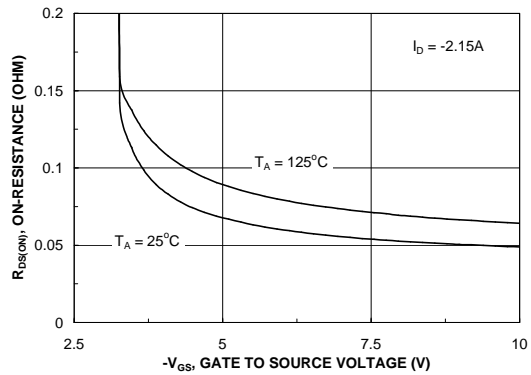


Figure 4. On-Resistance Variation with Gate-to-Source Voltage.

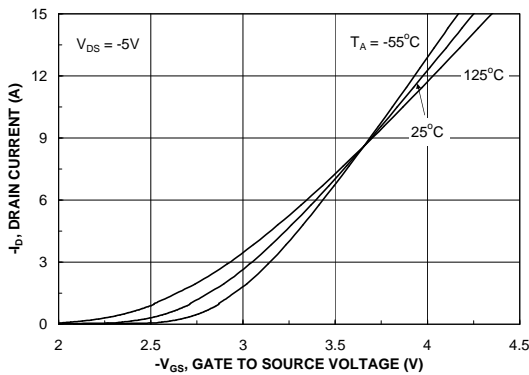


Figure 5. Transfer Characteristics.

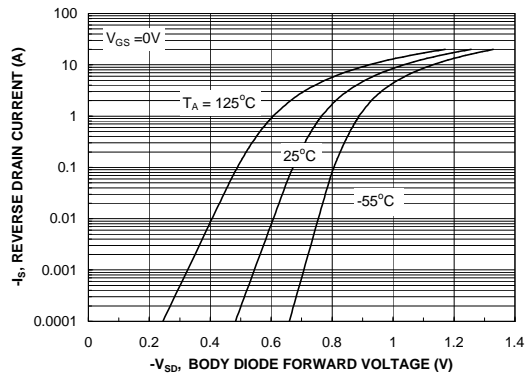


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.

Typical Characteristics: Q1

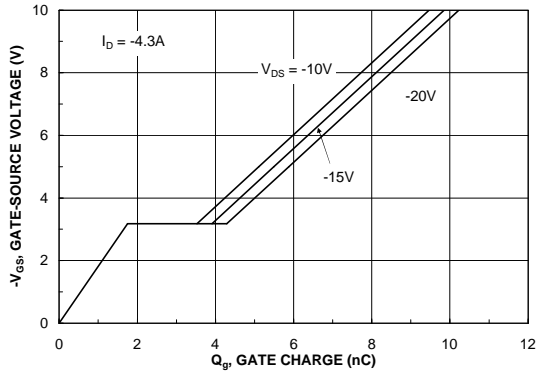


Figure 7. Gate Charge Characteristics.

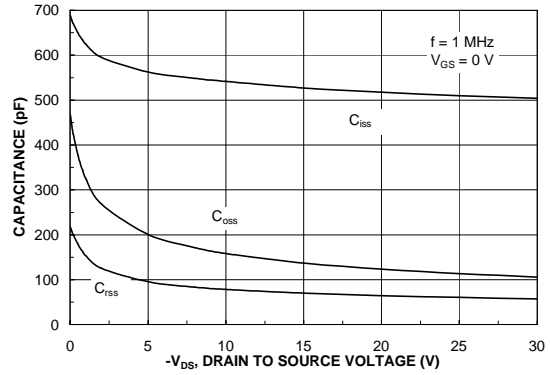


Figure 8. Capacitance Characteristics.

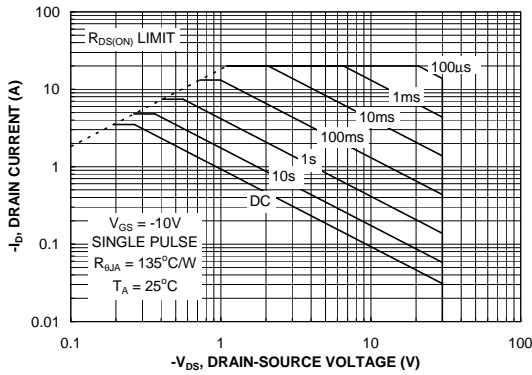


Figure 9. Maximum Safe Operating Area.

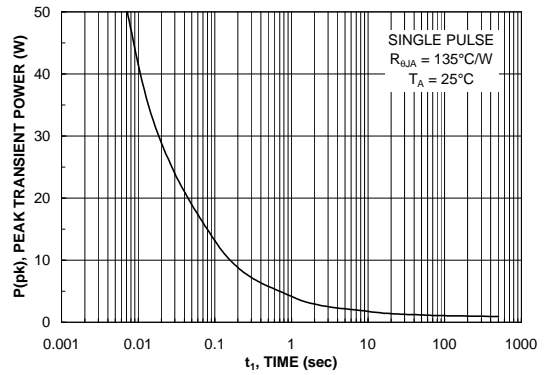


Figure 10. Single Pulse Maximum Power Dissipation.

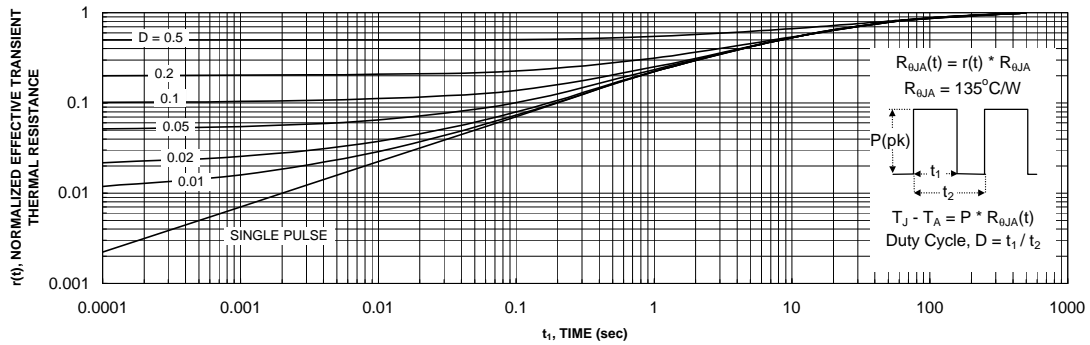


Figure 11. Transient Thermal Response Curve.

Thermal characterization performed using the conditions described in Note 1c. Transient thermal response will change depending on the circuit board design.

Typical Characteristics: Q2

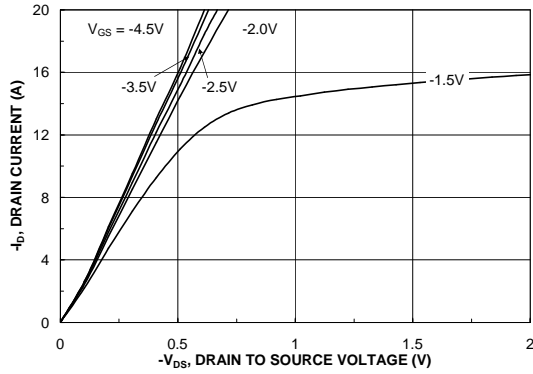


Figure 12. On-Region Characteristics.

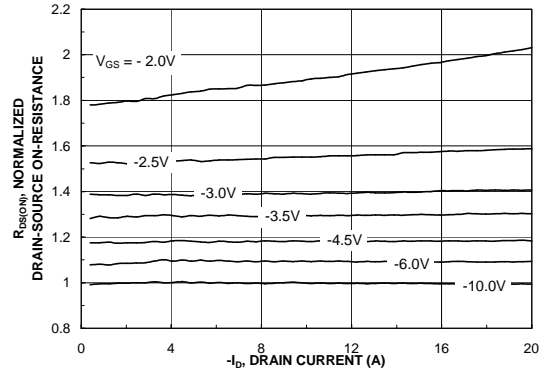


Figure 13. On-Resistance Variation with Drain Current and Gate Voltage.

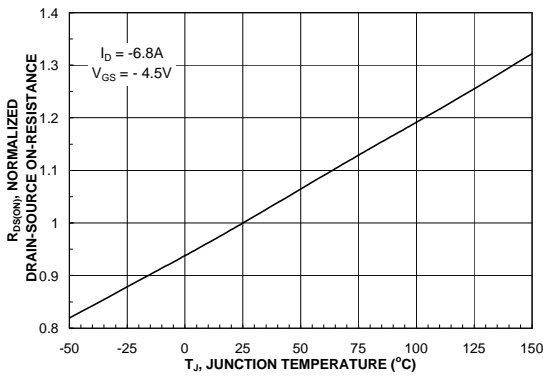


Figure 14. On-Resistance Variation with Temperature.

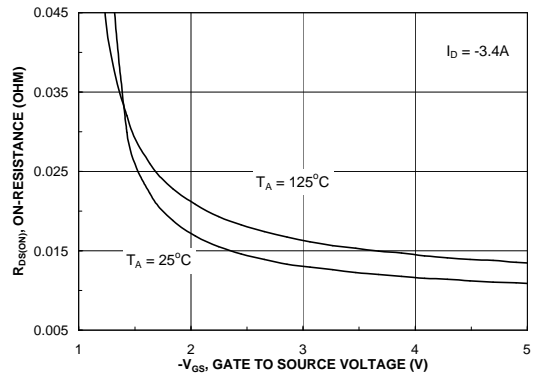


Figure 15. On-Resistance Variation with Gate-to-Source Voltage.

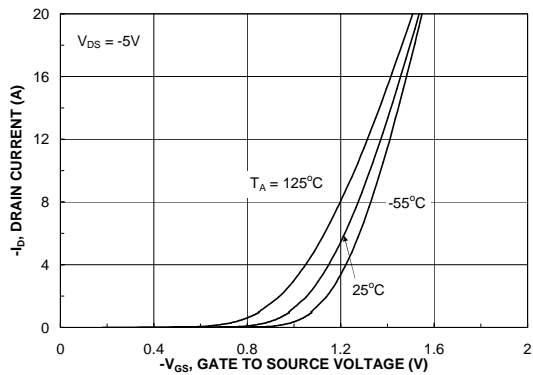


Figure 16. Transfer Characteristics.

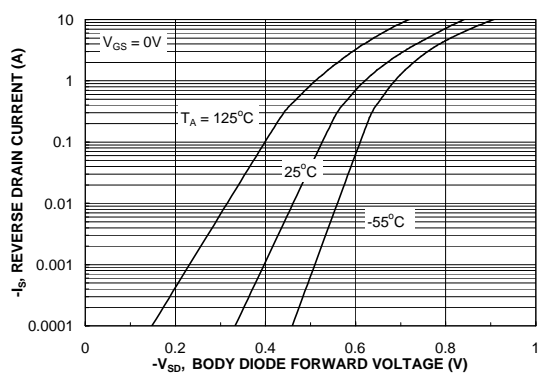


Figure 17. Body Diode Forward Voltage Variation with Source Current and Temperature.

Typical Characteristics: Q2

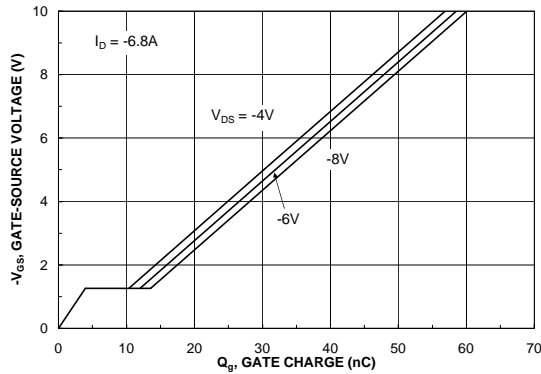


Figure 18. Gate Charge Characteristics.

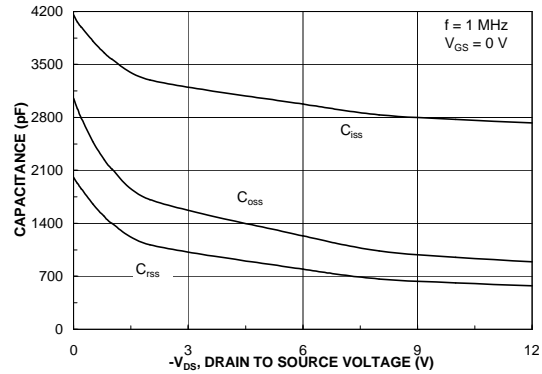


Figure 19. Capacitance Characteristics.

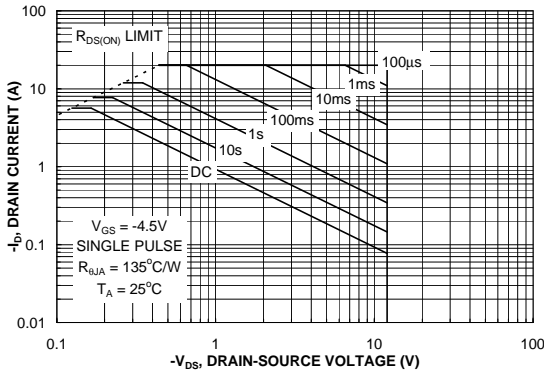


Figure 20. Maximum Safe Operating Area.

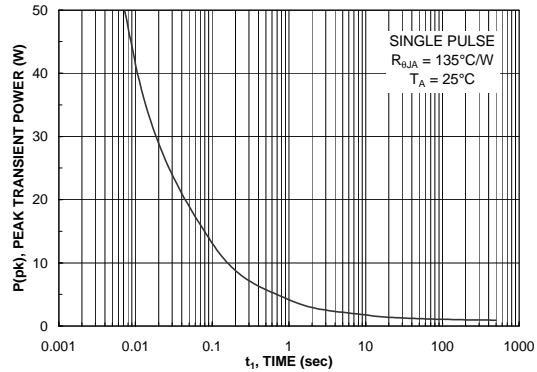


Figure 21. Single Pulse Maximum Power Dissipation.

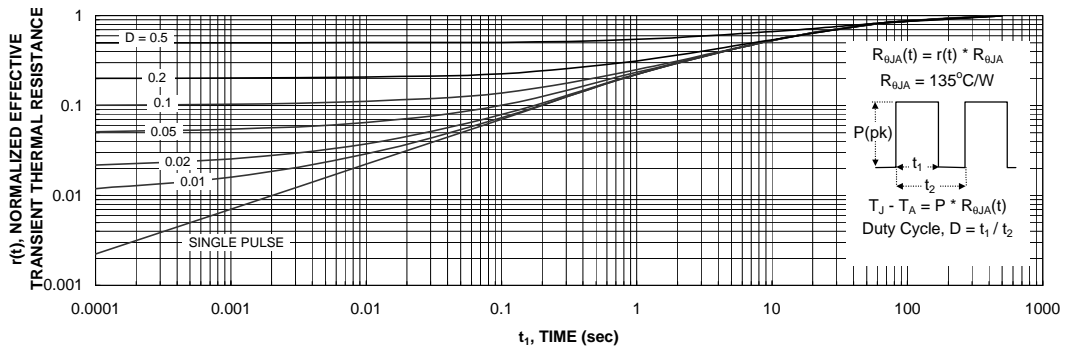


Figure 22. Transient Thermal Response Curve.

Thermal characterization performed using the conditions described in Note 1c. Transient thermal response will change depending on the circuit board design.

