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# FDD86540

## N-Channel PowerTrench<sup>®</sup> MOSFET 60 V, 136 A, 4.1 mΩ

### Features

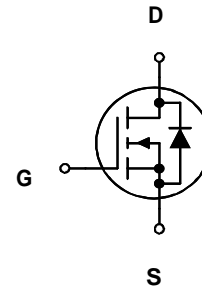
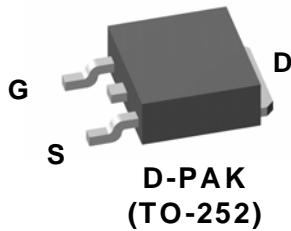
- Max  $r_{DS(on)}$  = 4.1 mΩ at  $V_{GS} = 10\text{ V}$ ,  $I_D = 21.5\text{ A}$
- Max  $r_{DS(on)}$  = 5 mΩ at  $V_{GS} = 8\text{ V}$ ,  $I_D = 19.5\text{ A}$
- 100% UIL tested
- RoHS Compliant

### General Description

This N-Channel MOSFET has been designed specifically to improve the overall efficiency and to minimize switch node ringing of DC/DC converters using either synchronous or conventional switching PWM controllers. It has been optimized for low gate charge, low  $r_{DS(on)}$ , fast switching speed and body diode reverse recovery performance.

### Applications

- Primary Switch in isolated DC-DC
- Synchronous Rectifier
- Load Switch



### MOSFET Maximum Ratings $T_C = 25\text{ °C}$ unless otherwise noted

Symbol	Parameter	Ratings	Units
$V_{DS}$	Drain to Source Voltage	60	V
$V_{GS}$	Gate to Source Voltage	±20	V
$I_D$	Drain Current -Continuous	$T_C = 25\text{ °C}$ (Note 5)	136
	-Continuous	$T_C = 100\text{ °C}$ (Note 5)	86
	-Continuous	$T_A = 25\text{ °C}$ (Note 1a)	21.5
	-Pulsed	(Note 4)	240
$E_{AS}$	Single Pulse Avalanche Energy	(Note 3)	228
$P_D$	Power Dissipation	$T_C = 25\text{ °C}$	127
	Power Dissipation	$T_A = 25\text{ °C}$ (Note 1a)	3.1
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to +150	°C

### Thermal Characteristics

$R_{\theta JC}$	Thermal Resistance, Junction to Case	0.98	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1a)	40	

### Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FDD86540	FDD86540	D-PAK(TO-252)	13 "	16 mm	2500 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	$I_D = 250\text{ }\mu\text{A}, V_{GS} = 0\text{ V}$	60			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 250\text{ }\mu\text{A}$ , referenced to $25\text{ }^\circ\text{C}$		28		mV/ $^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 48\text{ V}, V_{GS} = 0\text{ V}$			1	$\mu\text{A}$
$I_{GSS}$	Gate to Source Leakage Current	$V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$			$\pm 100$	nA

### On Characteristics

$V_{GS(th)}$	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}, I_D = 250\text{ }\mu\text{A}$	2	3.1	4	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate to Source Threshold Voltage Temperature Coefficient	$I_D = 250\text{ }\mu\text{A}$ , referenced to $25\text{ }^\circ\text{C}$		-11		mV/ $^\circ\text{C}$
$r_{DS(on)}$	Static Drain to Source On Resistance	$V_{GS} = 10\text{ V}, I_D = 21.5\text{ A}$		3.4	4.1	m $\Omega$
		$V_{GS} = 8\text{ V}, I_D = 19.5\text{ A}$		4.1	5	
		$V_{GS} = 10\text{ V}, I_D = 21.5\text{ A}, T_J = 125\text{ }^\circ\text{C}$		5.2	6.3	
$g_{FS}$	Forward Transconductance	$V_{DS} = 10\text{ V}, I_D = 21.5\text{ A}$		75		S

### Dynamic Characteristics

$C_{iss}$	Input Capacitance	$V_{DS} = 30\text{ V}, V_{GS} = 0\text{ V},$ $f = 1\text{ MHz}$		4767	6340	pF
$C_{oss}$	Output Capacitance			1409	1880	pF
$C_{riss}$	Reverse Transfer Capacitance			48	90	pF
$R_g$	Gate Resistance			0.6		$\Omega$

### Switching Characteristics

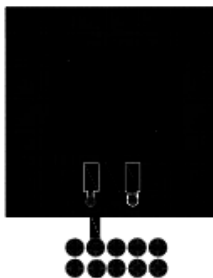
$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 30\text{ V}, I_D = 21.5\text{ A},$ $V_{GS} = 10\text{ V}, R_{GEN} = 6\text{ }\Omega$		26	42	ns
$t_r$	Rise Time			15	28	ns
$t_{d(off)}$	Turn-Off Delay Time			31	49	ns
$t_f$	Fall Time			6.9	14	ns
$Q_g$	Total Gate Charge	$V_{GS} = 0\text{ V to } 10\text{ V}$	$V_{DD} = 30\text{ V},$ $I_D = 21.5\text{ A}$	65	90	nC
$Q_g$	Total Gate Charge	$V_{GS} = 0\text{ V to } 8\text{ V}$		54	75	nC
$Q_{gs}$	Gate to Source Charge			23		nC
$Q_{gd}$	Gate to Drain "Miller" Charge			12		nC

### Drain-Source Diode Characteristics

$V_{SD}$	Source-Drain Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 21.5\text{ A}$ (Note 2)		0.8	1.3	V
		$V_{GS} = 0\text{ V}, I_S = 2.6\text{ A}$ (Note 2)		0.7	1.2	V
$t_{rr}$	Reverse Recovery Time	$I_F = 21.5\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$		56	90	ns
$Q_{rr}$	Reverse Recovery Charge			43	69	nC

#### Notes:

- $R_{\theta JA}$  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.  $R_{\theta JA}$  is determined by the user's board design.



a)  $40\text{ }^\circ\text{C/W}$  when mounted on a  $1\text{ in}^2$  pad of 2 oz copper



b)  $96\text{ }^\circ\text{C/W}$  when mounted on a minimum pad

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

3: Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 0.3\text{ mH}$ ,  $I_{AS} = 39\text{ A}$ ,  $V_{DD} = 54\text{ V}$ ,  $V_{GS} = 10\text{ V}$ .

4: Pulsed  $I_d$  please refer to Fig 11 SOA graph for more details.

5: Computed continuous current limited to Max Junction Temperature only, actual continuous current will be limited by thermal & electro-mechanical application board design.

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

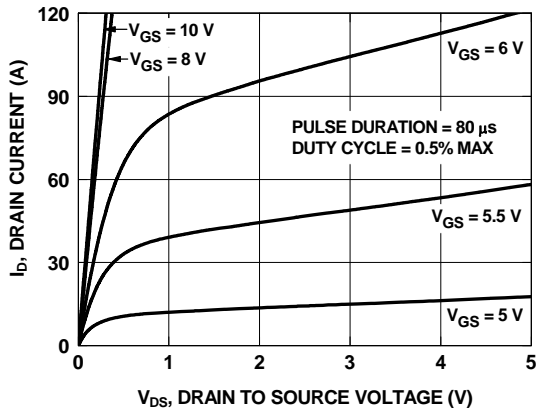


Figure 1. On-Region Characteristics

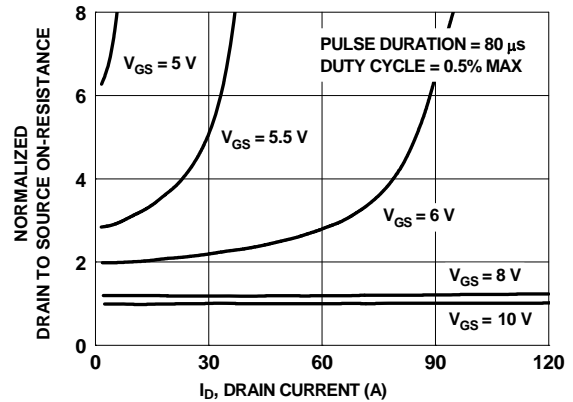


Figure 2. Normalized On-Resistance vs Drain Current and Gate Voltage

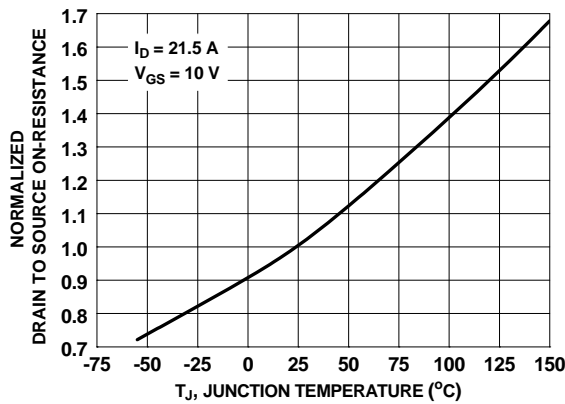


Figure 3. Normalized On-Resistance vs Junction Temperature

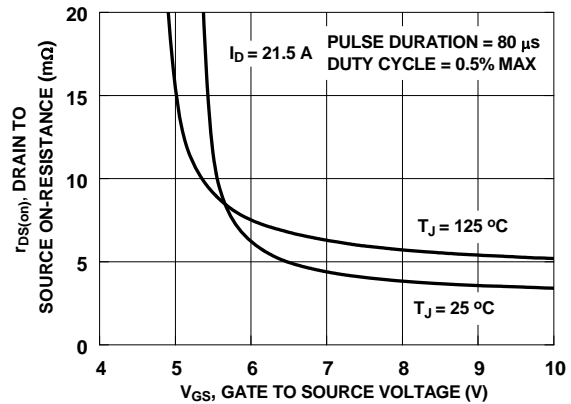


Figure 4. On-Resistance vs Gate to Source Voltage

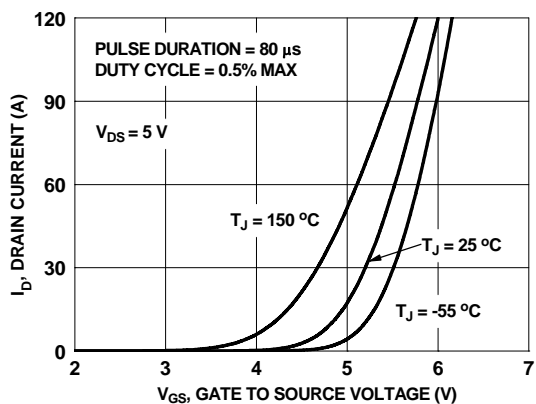


Figure 5. Transfer Characteristics

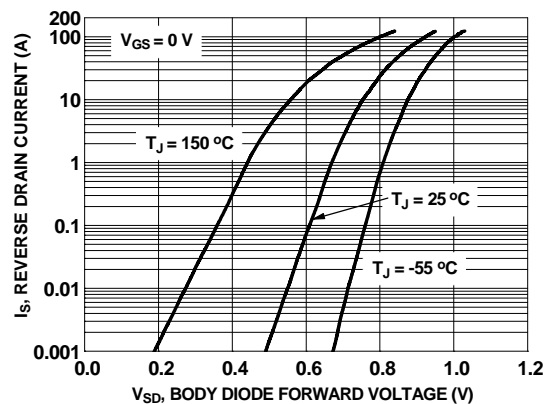
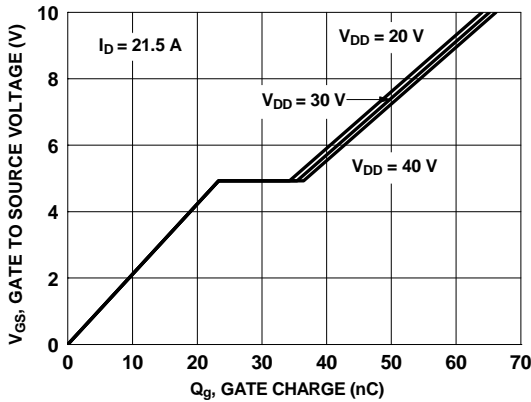
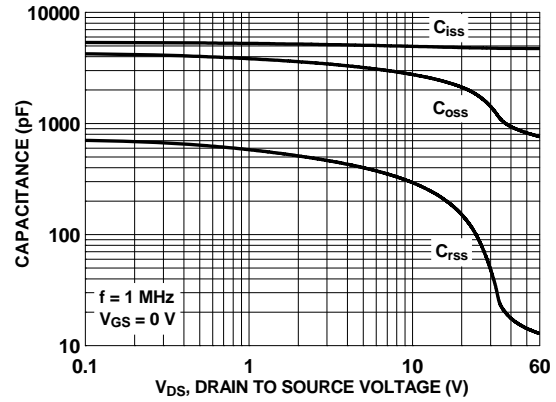


Figure 6. Source to Drain Diode Forward Voltage vs Source Current

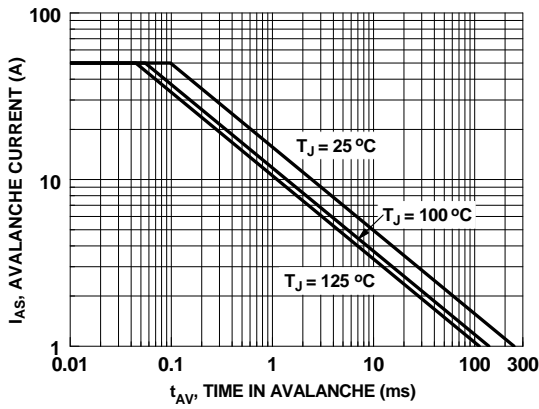
**Typical Characteristics**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted



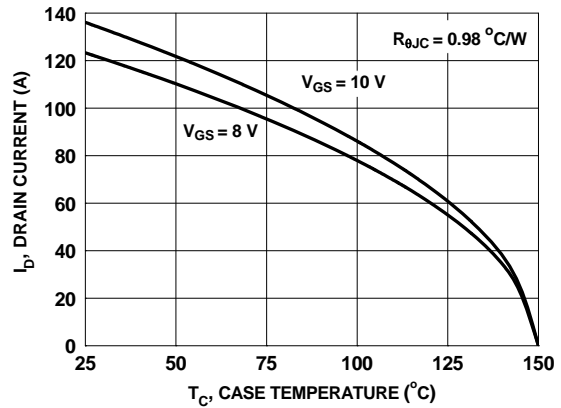
**Figure 7. Gate Charge Characteristics**



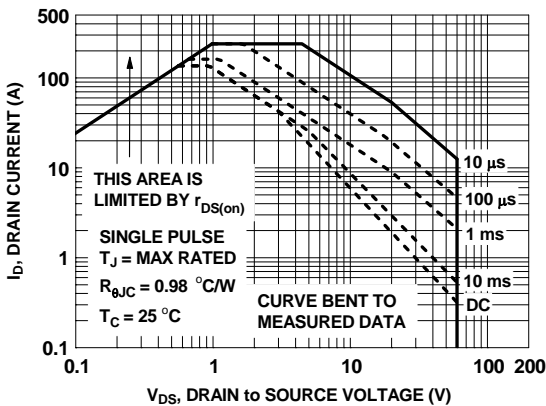
**Figure 8. Capacitance vs Drain to Source Voltage**



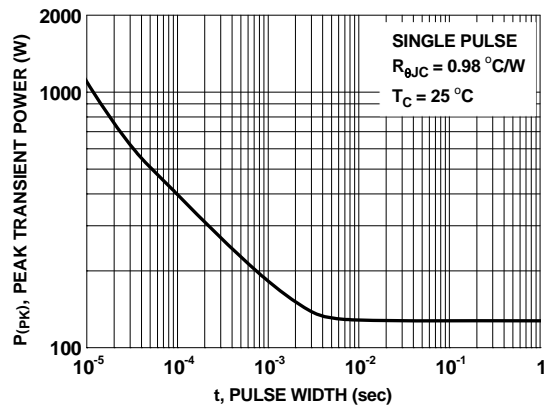
**Figure 9. Unclamped Inductive Switching Capability**



**Figure 10. Maximum Continuous Drain Current vs Case Temperature**

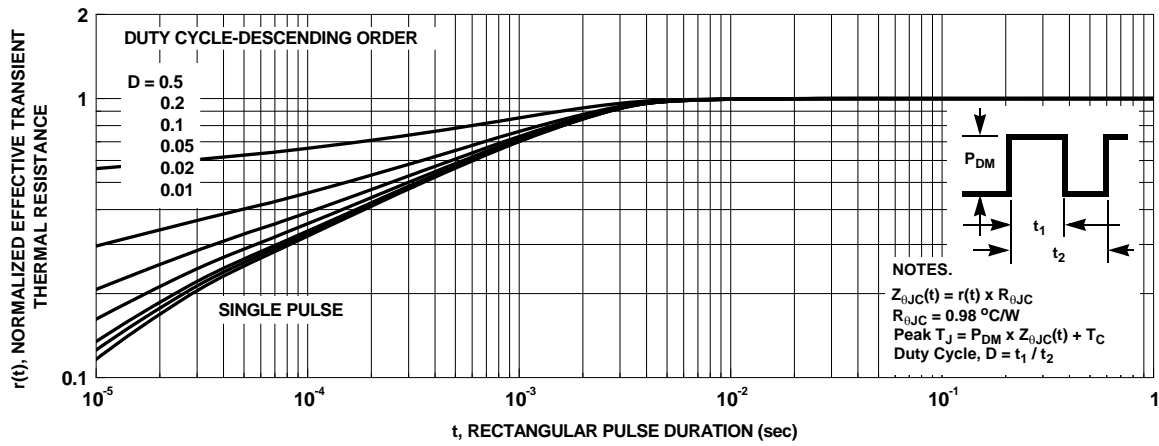


**Figure 11. Forward Bias Safe Operating Area**

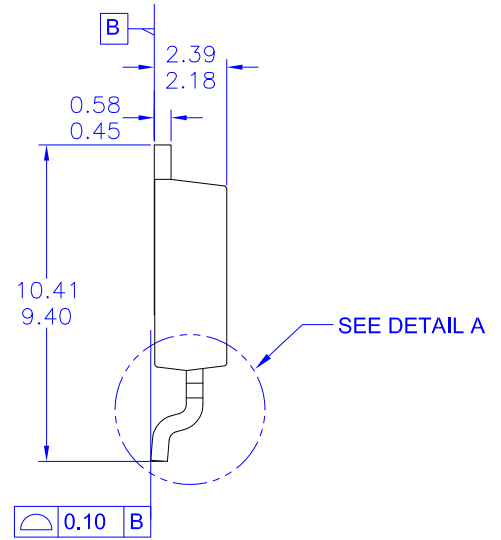
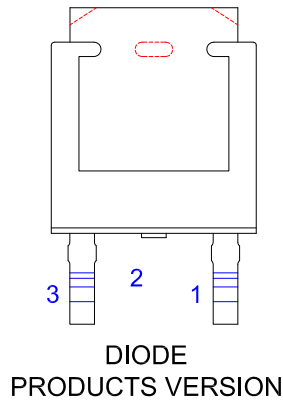
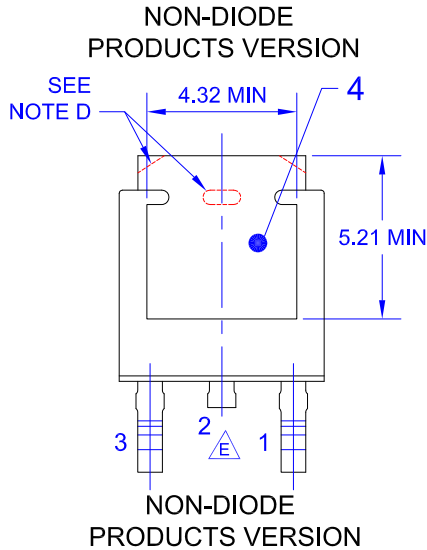
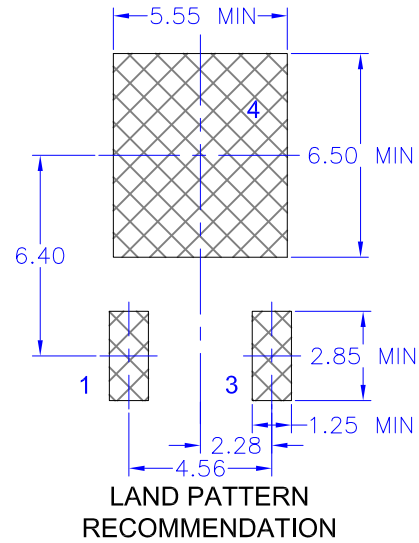
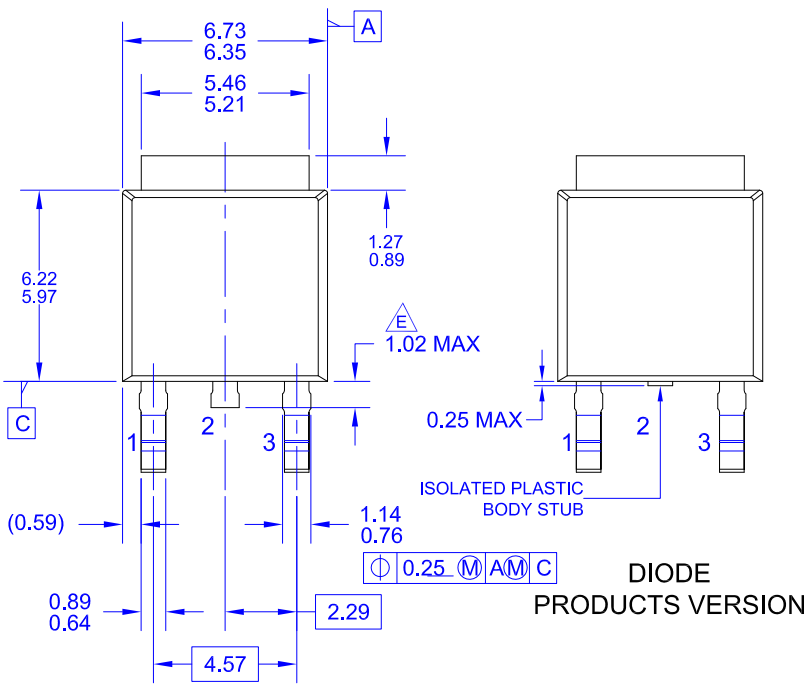


**Figure 12. Single Pulse Maximum Power Dissipation**

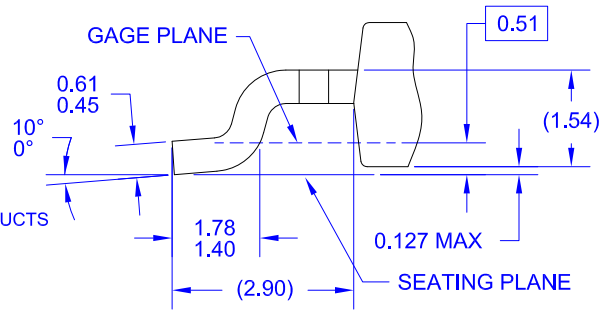
**Typical Characteristics**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted



**Figure 13. Junction-to-Case Transient Thermal Response Curve**



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- A) THIS PACKAGE CONFORMS TO JEDEC, TO-252, ISSUE C, VARIATION AA.
  - B) ALL DIMENSIONS ARE IN MILLIMETERS.
  - C) DIMENSIONING AND TOLERANCING PER ASME Y14.5M-2009.
  - D) SUPPLIER DEPENDENT MOLD LOCKING HOLES OR CHAMFERED CORNERS OR EDGE PROTRUSION.
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  - F) DIMENSIONS ARE EXCLUSIVE OF BURS, MOLD FLASH AND TIE BAR EXTRUSIONS.
  - G) LAND PATTERN RECOMMENDATION IS BASED ON IPC7351A STD TO228P991X239-3N.
  - H) DRAWING NUMBER AND REVISION: MKT-TO252A03REV11



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