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# FQU5N40

## N-Channel QFET® MOSFET

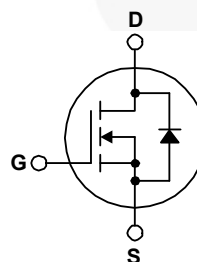
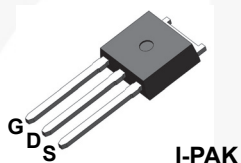
400 V, 3.4 A, 1.6 Ω

### Description

This N-Channel enhancement mode power MOSFET is produced using Fairchild Semiconductor's proprietary planar stripe and DMOS technology. This advanced MOSFET technology has been especially tailored to reduce on-state resistance, and to provide superior switching performance and high avalanche energy strength. These devices are suitable for switched mode power supplies, active power factor correction (PFC), and electronic lamp ballasts.

### Features

- 3.4 A, 400 V,  $R_{DS(on)} = 1.6 \Omega$  (Max.) @  $V_{GS} = 10 V$ ,  $I_D = 1.7 A$
- Low Gate Charge (Typ. 10 nC)
- Low  $C_{rss}$  (Typ. 7 pF)
- 100% Avalanche Tested



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

Symbol	Parameter	FQU5N40TU	Unit
$V_{DSS}$	Drain-Source Voltage	400	V
$I_D$	Drain Current - Continuous ( $T_C = 25^\circ C$ )	3.4	A
	Drain Current - Continuous ( $T_C = 100^\circ C$ )	2.15	A
$I_{DM}$	Drain Current - Pulsed (Note 1)	13.6	A
$V_{GSS}$	Gate-Source Voltage	$\pm 30$	V
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)	290	mJ
$I_{AR}$	Avalanche Current (Note 1)	3.4	A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)	4.5	mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	4.5	V/ns
$P_D$	Power Dissipation ( $T_A = 25^\circ C$ ) *	2.5	W
	Power Dissipation ( $T_C = 25^\circ C$ )	45	W
	- Derate above $25^\circ C$	0.36	W/ $^\circ C$
$T_J, T_{STG}$	Operating and Storage Temperature Range	-55 to +150	$^\circ C$
$T_L$	Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds.	300	$^\circ C$

### Thermal Characteristics

Symbol	Parameter	FQU5N40TU	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	2.78	$^\circ C/W$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Minimum Pad of 2-oz Copper), Max.	110	
	Thermal Resistance, Junction to Ambient (*1 in <sup>2</sup> Pad of 2-oz Copper), Max.	50	

## Package Marking and Ordering Information

Part Number	Top Mark	Package	Packing Method	Reel Size	Tape Width	Quantity
FQU5N40TU	FQU5N40	IPAK	Tube	N/A	N/A	70 units

## Electrical Characteristics

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
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### Off Characteristics

$BV_{DSS}$	Drain-Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$	400	--	--	V
$\Delta BV_{DSS} / \Delta T$	Breakdown Voltage Temperature Coefficient	$I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$	--	0.38	--	$\text{V}/^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}$	--	--	1	$\mu\text{A}$
		$V_{DS} = 320\text{ V}, T_C = 125^\circ\text{C}$	--	--	10	$\mu\text{A}$
$I_{GSSF}$	Gate-Body Leakage Current, Forward	$V_{GS} = 30\text{ V}, V_{DS} = 0\text{ V}$	--	--	100	nA
$I_{GSSR}$	Gate-Body Leakage Current, Reverse	$V_{GS} = -30\text{ V}, V_{DS} = 0\text{ V}$	--	--	-100	nA

### On Characteristics

$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$	3.0	--	5.0	V
$R_{DS(on)}$	Static Drain-Source On-Resistance	$V_{GS} = 10\text{ V}, I_D = 1.7\text{ A}$	--	1.27	1.6	$\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS} = 50\text{ V}, I_D = 1.7\text{ A}$	--	2.9	--	S

### Dynamic Characteristics

$C_{iss}$	Input Capacitance	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$	--	350	460	pF
$C_{oss}$	Output Capacitance		--	60	80	pF
$C_{rss}$	Reverse Transfer Capacitance		--	7	9	pF

### Switching Characteristics

$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 200\text{ V}, I_D = 4.5\text{ A},$ $R_G = 25\ \Omega$	--	12	30	ns
$t_r$	Turn-On Rise Time		--	60	130	ns
$t_{d(off)}$	Turn-Off Delay Time		--	20	50	ns
$t_f$	Turn-Off Fall Time		(Note 4)	--	30	70
$Q_g$	Total Gate Charge	$V_{DS} = 320\text{ V}, I_D = 4.5\text{ A},$ $V_{GS} = 10\text{ V}$	--	10	13	nC
$Q_{gs}$	Gate-Source Charge		--	3.0	--	nC
$Q_{gd}$	Gate-Drain Charge		(Note 4)	--	4.5	--

### Drain-Source Diode Characteristics and Maximum Ratings

$I_S$	Maximum Continuous Drain-Source Diode Forward Current	--	--	3.4	A	
$I_{SM}$	Maximum Pulsed Drain-Source Diode Forward Current	--	--	13.6	A	
$V_{SD}$	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 3.4\text{ A}$	--	--	1.5	V
$t_{rr}$	Reverse Recovery Time	$V_{GS} = 0\text{ V}, I_S = 4.5\text{ A},$	--	190	--	ns
$Q_{rr}$	Reverse Recovery Charge	$di_F / dt = 100\text{ A}/\mu\text{s}$	--	1.0	--	$\mu\text{C}$

#### Notes:

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2.  $L = 44\text{ mH}, I_{AS} = 3.4\text{ A}, V_{DD} \leq 50\text{ V}, R_G = 25\ \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 4.5\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature.

## Typical Characteristics

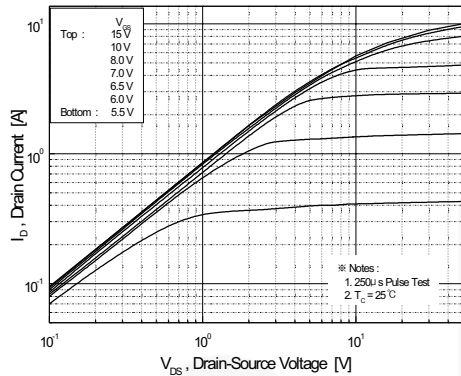


Figure 1. On-Region Characteristics

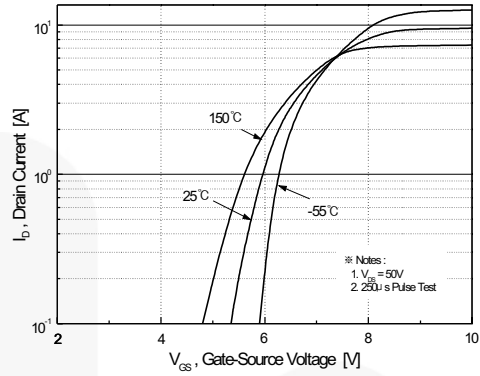


Figure 2. Transfer Characteristics

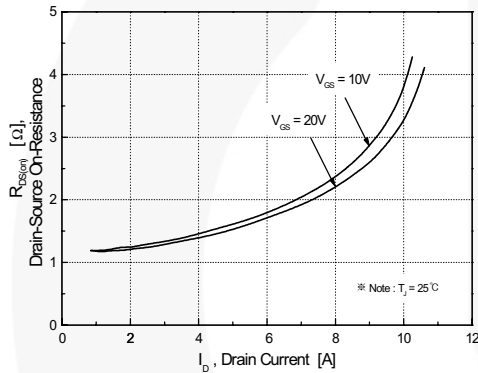


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

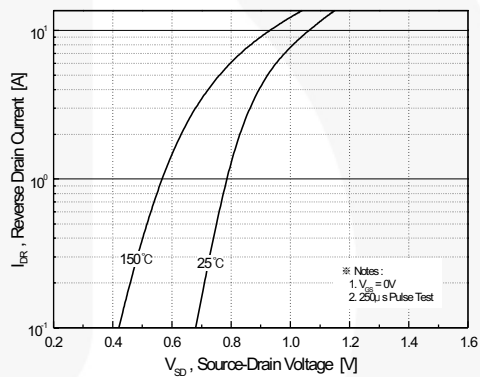


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

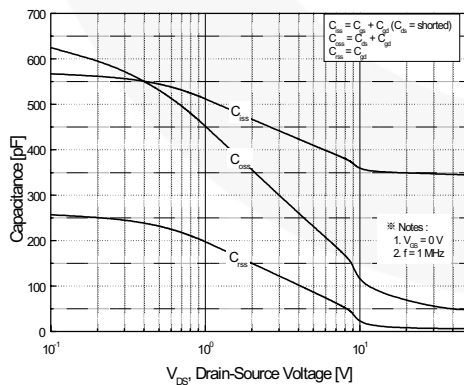


Figure 5. Capacitance Characteristics

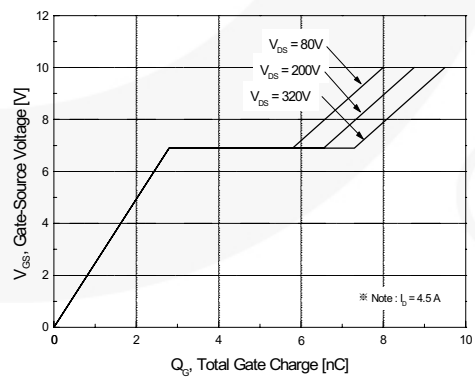
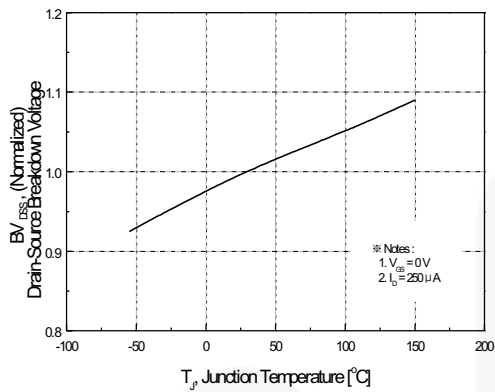
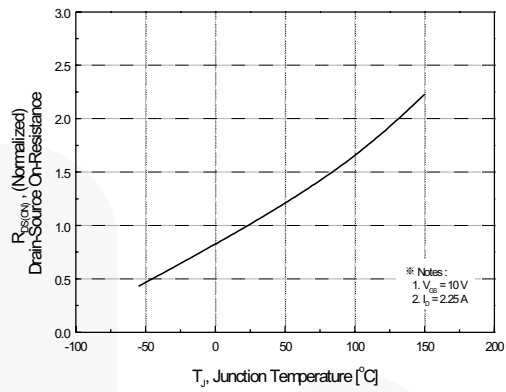


Figure 6. Gate Charge Characteristics

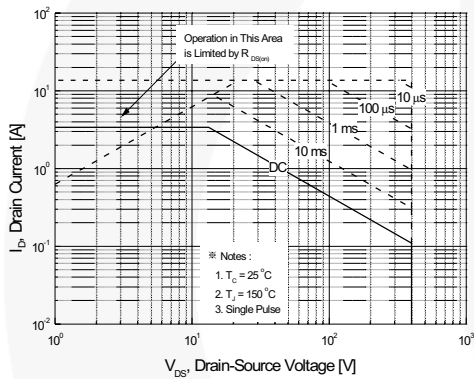
**Typical Characteristics** (Continued)



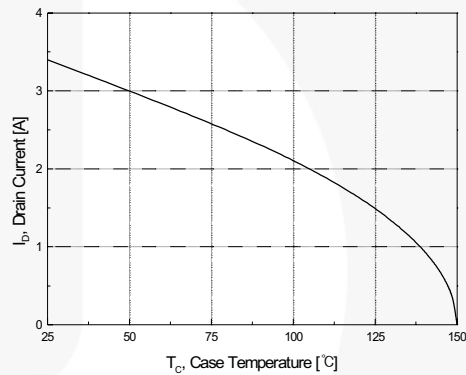
**Figure 7. Breakdown Voltage Variation vs. Temperature**



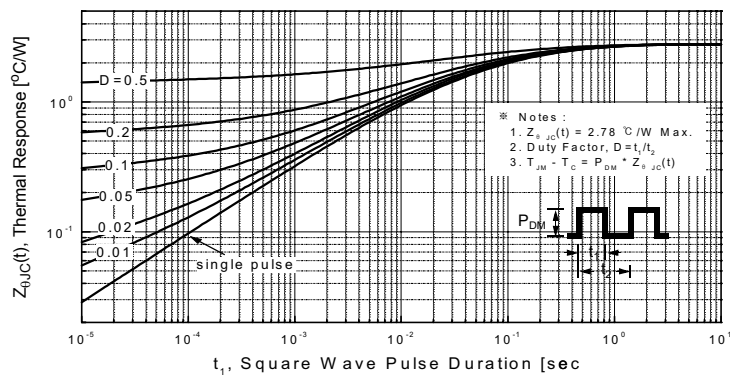
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**



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



**Figure 11. Transient Thermal Response Curve**

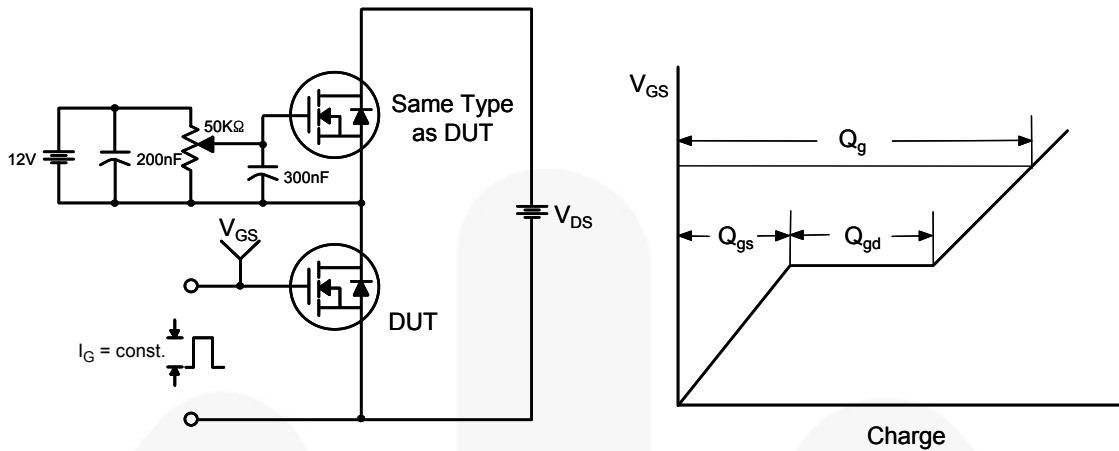


Figure 12. Gate Charge Test Circuit & Waveform

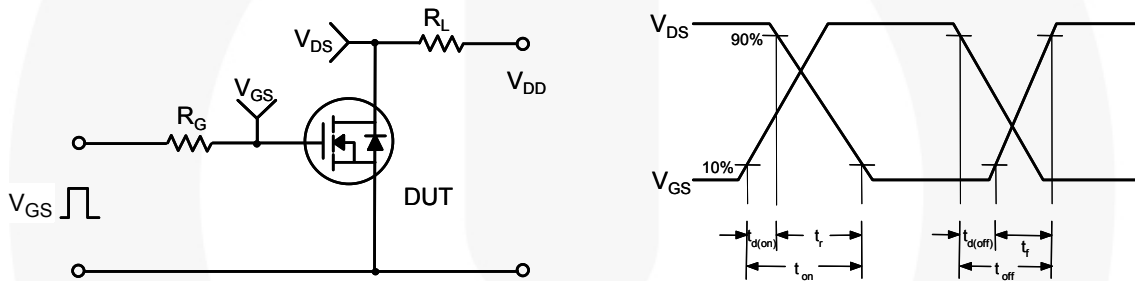


Figure 13. Resistive Switching Test Circuit & Waveforms

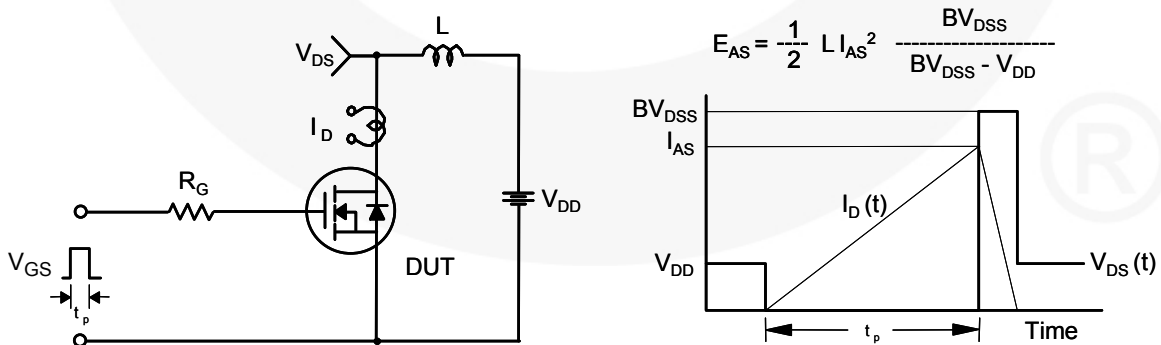


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms

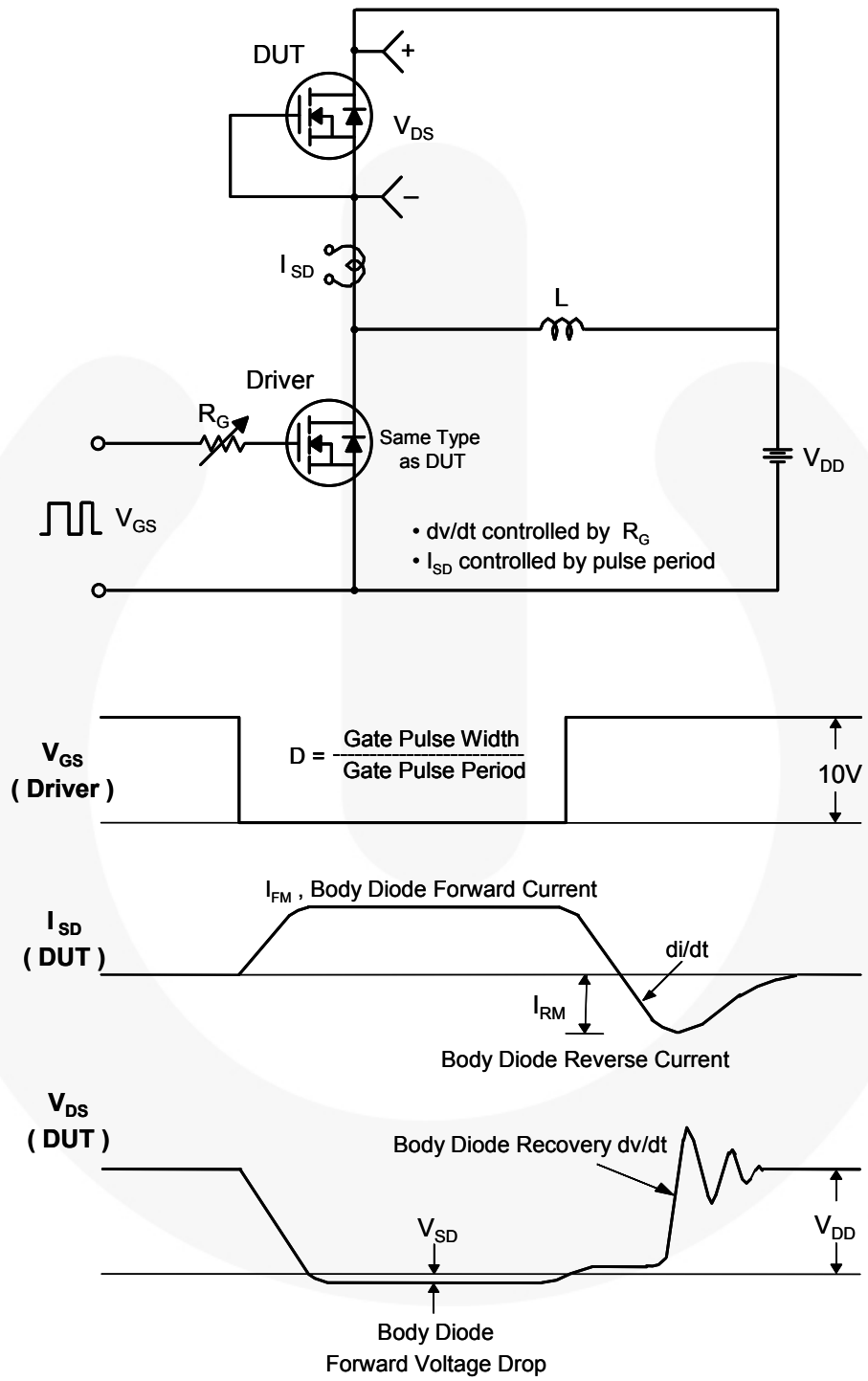
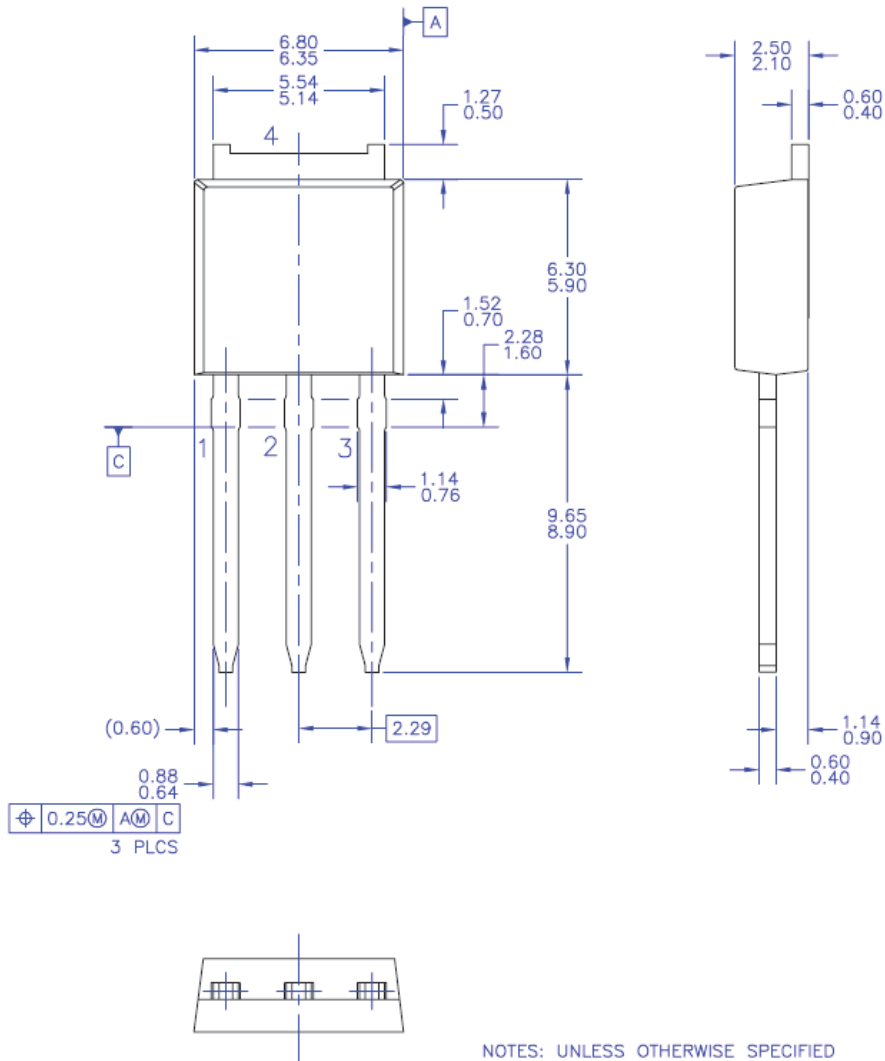


Figure 15. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms

## Mechanical Dimensions



NOTES: UNLESS OTHERWISE SPECIFIED

- A) ALL DIMENSIONS ARE IN MILLIMETERS.
- B) THIS PACKAGE CONFORMS TO JEDEC, TO-251, ISSUE C, VARIATION AA, DATED SEP 1988.
- C) DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.

**Figure 16. TO251 (I-PAK), Molded, 3-Lead**

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