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July 2016

# FQD13N06L / FQU13N06L

## N-Channel QFET<sup>®</sup> MOSFET

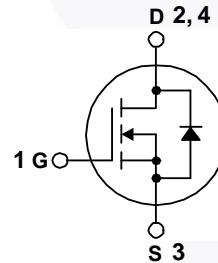
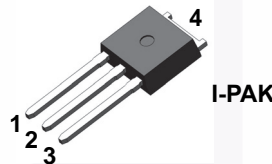
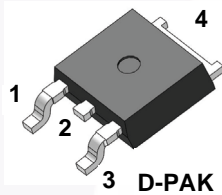
60 V, 11 A, 115 mΩ

### 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, audio amplifier, DC motor control, and variable switching power applications.

### Features

- 11 A, 60 V,  $R_{DS(on)} = 115 \text{ m}\Omega$  (Max) @  $V_{GS} = 10 \text{ V}$ ,  $I_D = 5.5 \text{ A}$
- Low Gate Charge (Typ. 4.8 nC)
- Low  $C_{rss}$  (Typ. 17 pF)
- 100% Avalanche Tested
- Low Level Gate Drive Requirements Allowing Direct Operation from Logic Drivers



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

Symbol	Parameter	FQD13N06LTM / FQU13N06LTU FQU13N06LTU_WS	Unit
$V_{DSS}$	Drain-Source Voltage	60	V
$I_D$	Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ ) - Continuous ( $T_C = 100^\circ\text{C}$ )	11	A
		7	A
$I_{DM}$	Drain Current - Pulsed (Note 1)	44	A
$V_{GSS}$	Gate-Source Voltage	$\pm 20$	V
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)	90	mJ
$I_{AR}$	Avalanche Current (Note 1)	11	A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)	2.8	mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	7.0	V/ns
$P_D$	Power Dissipation ( $T_A = 25^\circ\text{C}$ ) *	2.5	W
	Power Dissipation ( $T_C = 25^\circ\text{C}$ ) - Derate above $25^\circ\text{C}$	28	W
		0.22	W/ $^\circ\text{C}$
$T_J, T_{STG}$	Operating and Storage Temperature Range	-55 to +150	$^\circ\text{C}$
$T_L$	Maximum Lead Temperature for Soldering, 1/8" from Case for Seconds	300	$^\circ\text{C}$

### Thermal Characteristics

Symbol	Parameter	FQD13N06LTM FQU13N06LTU FQU13N06LTU_WS	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	2.5	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	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	

FQD13N06L / FQU13N06L — N-Channel QFET<sup>®</sup> MOSFET

## Package Marking and Ordering Information

Part Number	Top Mark	Package	Packing Method	Reel Size	Tape Width	Quantity
FQD13N06LTM	FQD13N06L	D-PAK	Tape and Reel	330 mm	16 mm	2500 units
FQU13N06LTU	FQU13N06L	I-PAK	Tube	N/A	N/A	70 units
FQU13N06LTU_WS	FQU13N06LS	I-PAK	Tube	N/A	N/A	75 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	$V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$	60	--	--	V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$	--	0.05	--	V/ $^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$	--	--	1	$\mu\text{A}$
		$V_{DS} = 48\text{ V}, T_c = 150^\circ\text{C}$	--	--	10	$\mu\text{A}$
$I_{GSSF}$	Gate-Body Leakage Current, Forward	$V_{GS} = 20\text{ V}, V_{DS} = 0\text{ V}$	--	--	100	nA
$I_{GSSR}$	Gate-Body Leakage Current, Reverse	$V_{GS} = -20\text{ V}, V_{DS} = 0\text{ V}$	--	--	-100	nA

### On Characteristics

$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$	1.0	--	2.5	V
$R_{DS(on)}$	Static Drain-Source On-Resistance	$V_{GS} = 10\text{ V}, I_D = 5.5\text{ A}$	--	0.092	0.115	$\Omega$
		$V_{GS} = 5\text{ V}, I_D = 5.5\text{ A}$	--	0.115	0.145	
$g_{FS}$	Forward Transconductance	$V_{DS} = 25\text{ V}, I_D = 5.5\text{ A}$	--	6	--	S

### Dynamic Characteristics

$C_{iss}$	Input Capacitance	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$	--	270	350	pF
$C_{oss}$	Output Capacitance		--	95	125	pF
$C_{rss}$	Reverse Transfer Capacitance		--	17	23	pF

### Switching Characteristics

$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 30\text{ V}, I_D = 6.8\text{ A},$ $R_G = 25\ \Omega$	--	8	25	ns	
$t_r$	Turn-On Rise Time		--	90	190	ns	
$t_{d(off)}$	Turn-Off Delay Time		(Note 4)	--	20	50	ns
$t_f$	Turn-Off Fall Time		(Note 4)	--	40	90	ns
$Q_g$	Total Gate Charge	$V_{DS} = 48\text{ V}, I_D = 13.6\text{ A},$ $V_{GS} = 5\text{ V}$	--	4.8	6.4	nC	
$Q_{gs}$	Gate-Source Charge		(Note 4)	--	1.6	--	nC
$Q_{gd}$	Gate-Drain Charge		(Note 4)	--	2.7	--	nC

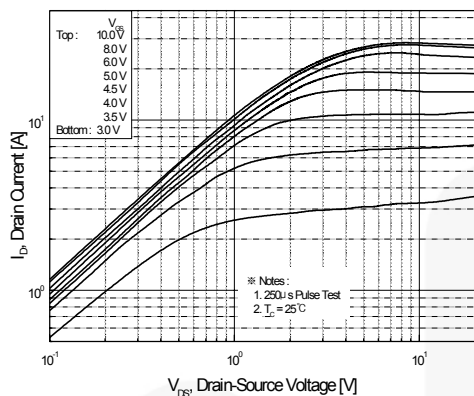
### Drain-Source Diode Characteristics and Maximum Ratings

$I_S$	Maximum Continuous Drain-Source Diode Forward Current	--	--	11	A	
$I_{SM}$	Maximum Pulsed Drain-Source Diode Forward Current	--	--	44	A	
$V_{SD}$	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 11\text{ A}$	--	--	1.5	V
$t_{rr}$	Reverse Recovery Time	$V_{GS} = 0\text{ V}, I_S = 13.6\text{ A},$ $dI_F / dt = 100\text{ A}/\mu\text{s}$	--	45	--	ns
$Q_{rr}$	Reverse Recovery Charge		--	45	--	nC

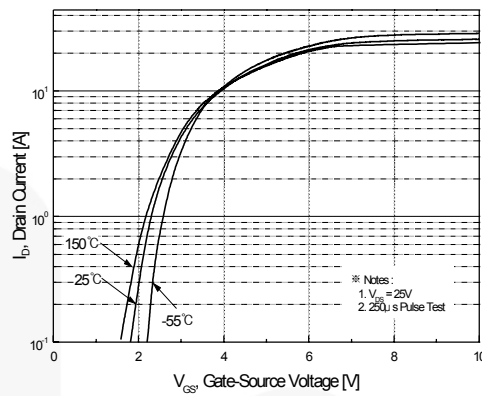
#### Notes:

1. Repetitive rating : pulse-width limited by maximum junction temperature.
2.  $L = 870\ \mu\text{H}, I_{AS} = 11\text{ A}, V_{DD} = 25\text{ V}, R_G = 25\ \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 13.6\text{ A}, di/dt \leq 300\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature.

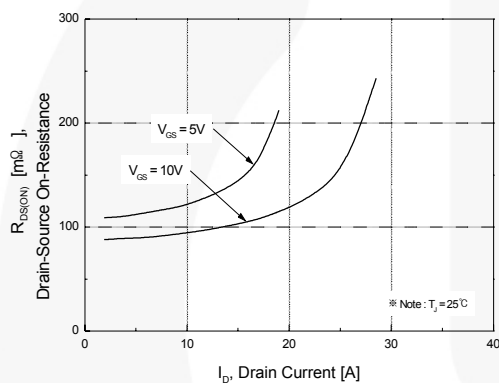
## Typical Characteristics



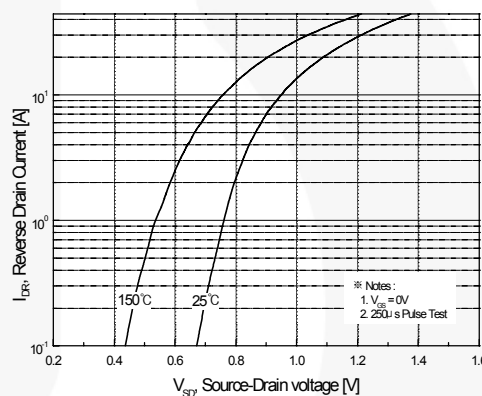
**Figure 1. On-Region Characteristics**



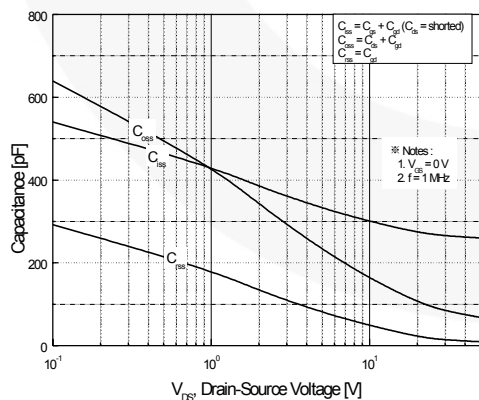
**Figure 2. Transfer Characteristics**



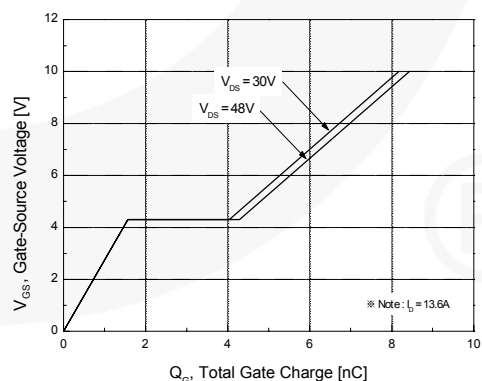
**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**



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

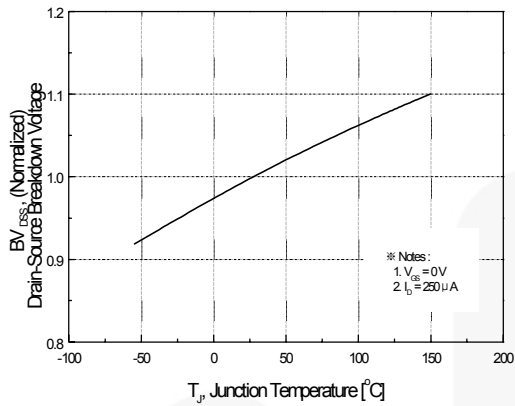


**Figure 5. Capacitance Characteristics**

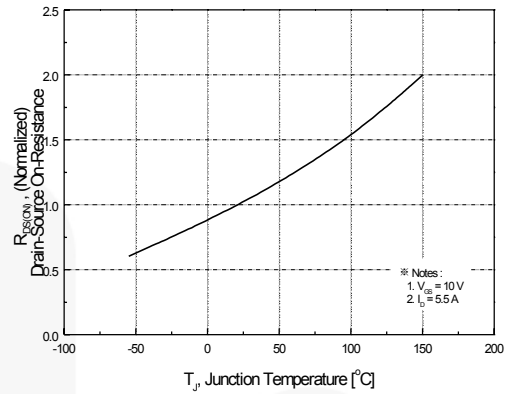


**Figure 6. Gate Charge Characteristics**

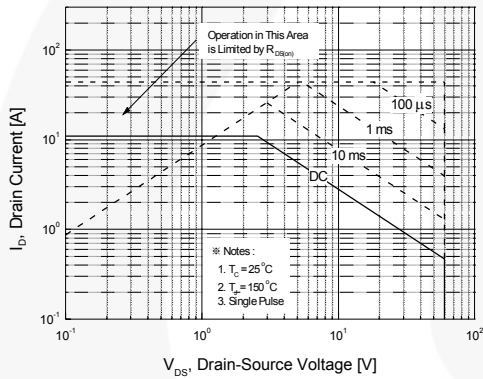
**Typical Characteristics** (Continued)



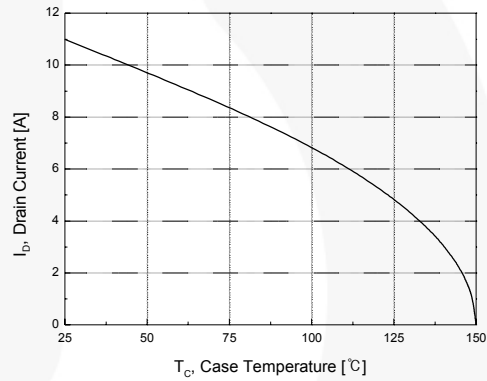
**Figure 7. Breakdown Voltage Variation vs. Temperature**



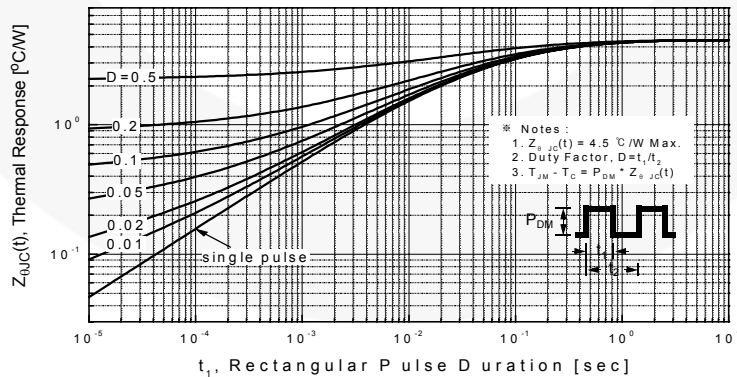
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**



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



**Figure 11. Transient Thermal Response Curve**

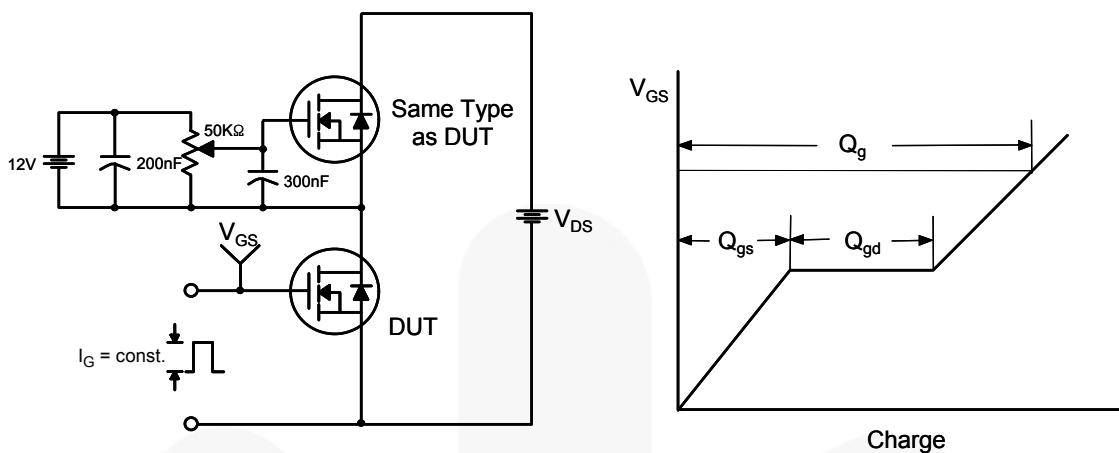


Figure 12. Gate Charge Test Circuit & Waveform

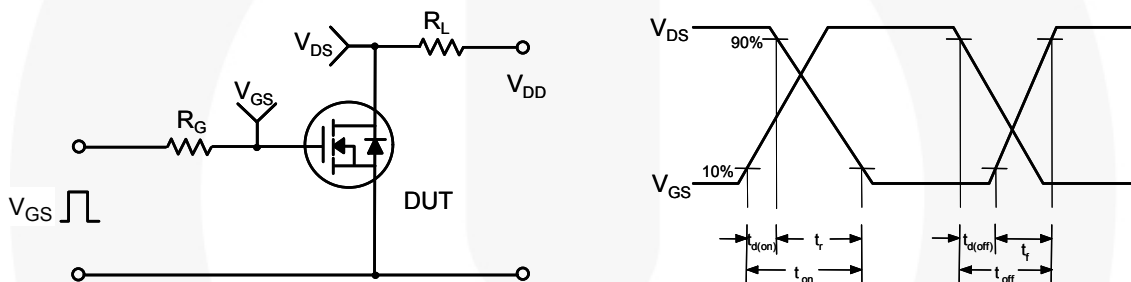


Figure 13. Resistive Switching Test Circuit & Waveforms

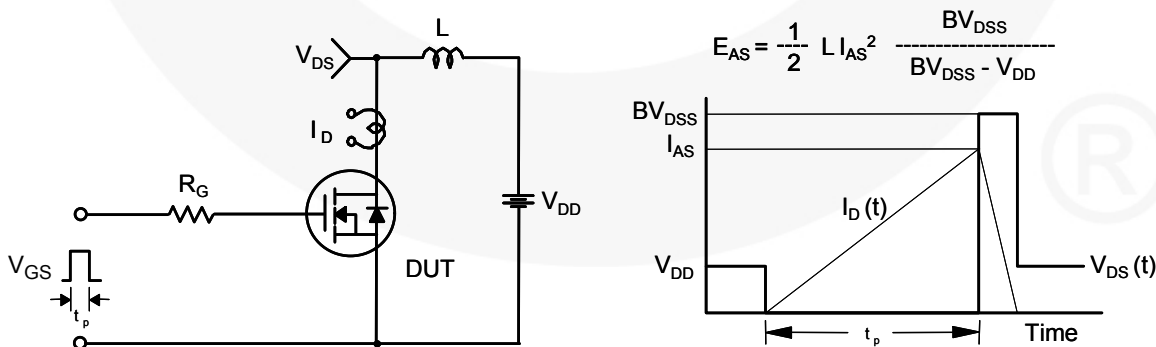


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms

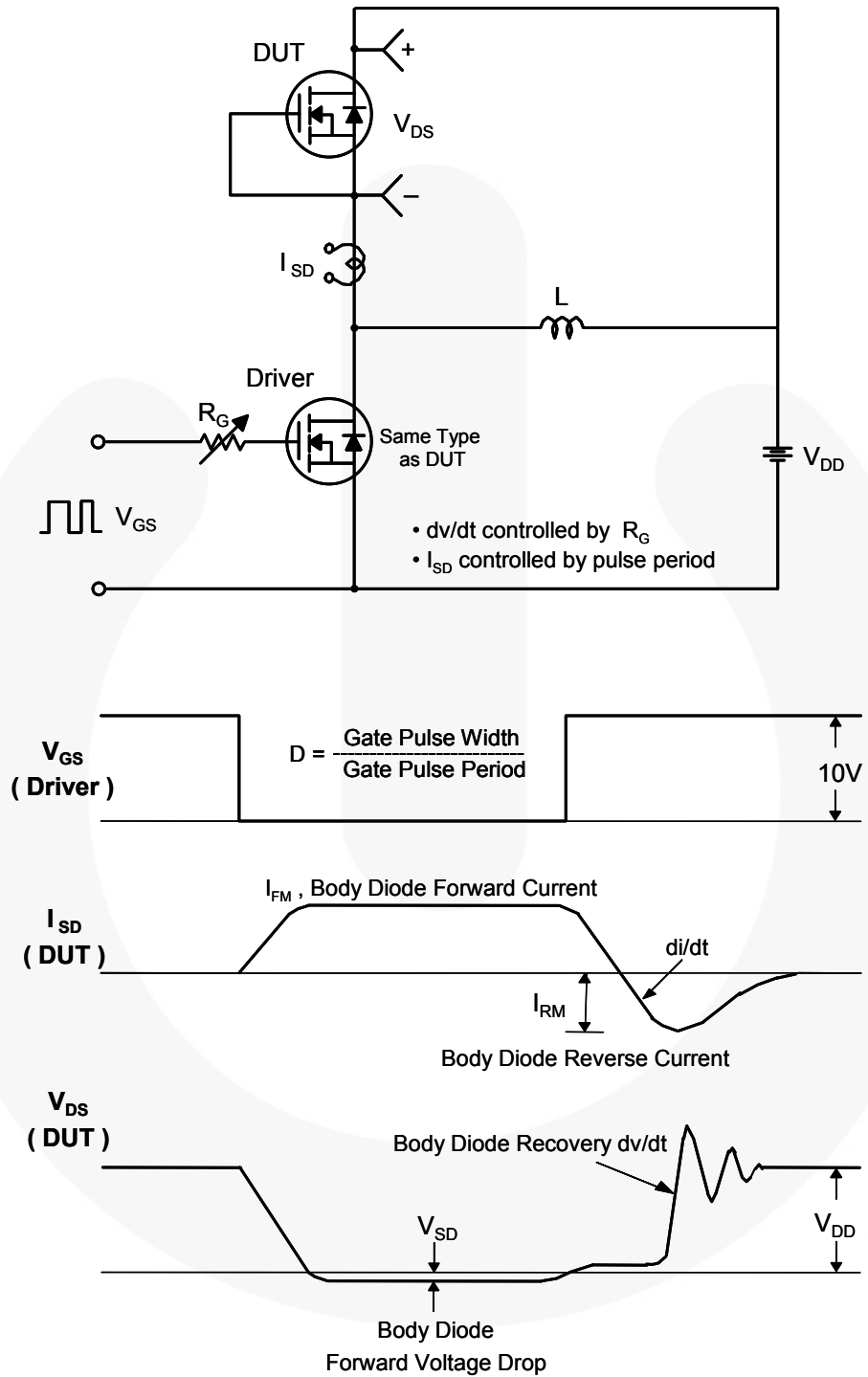
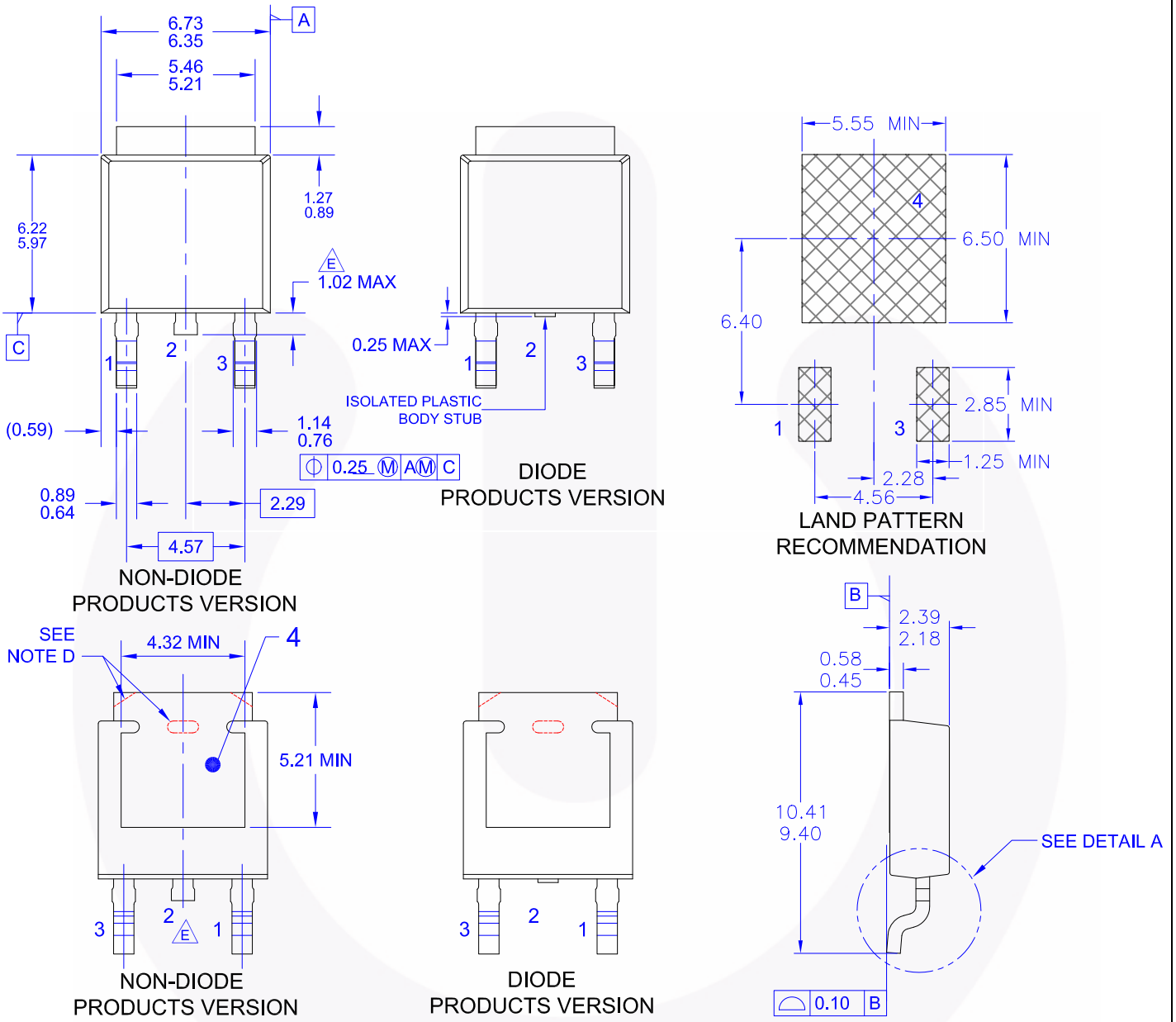


Figure 15. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms

### Mechanical Dimensions



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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.
  - E) TRIMMED METAL CENTER LEAD IS PRESENT ON FOR NON-DIODE PRODUCTS
  - 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

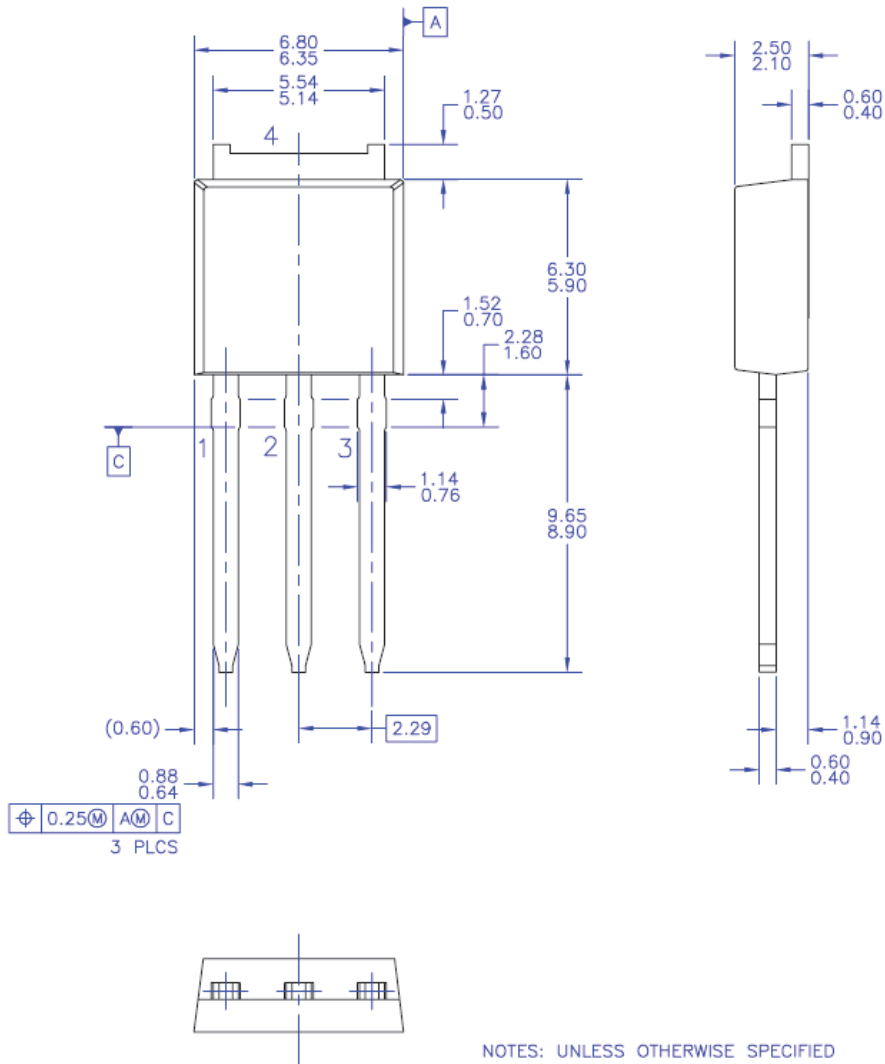
**DETAIL A**  
(ROTATED -90°)  
SCALE: 12X





**Mechanical Dimensions**

**FQU13N06LTU**



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

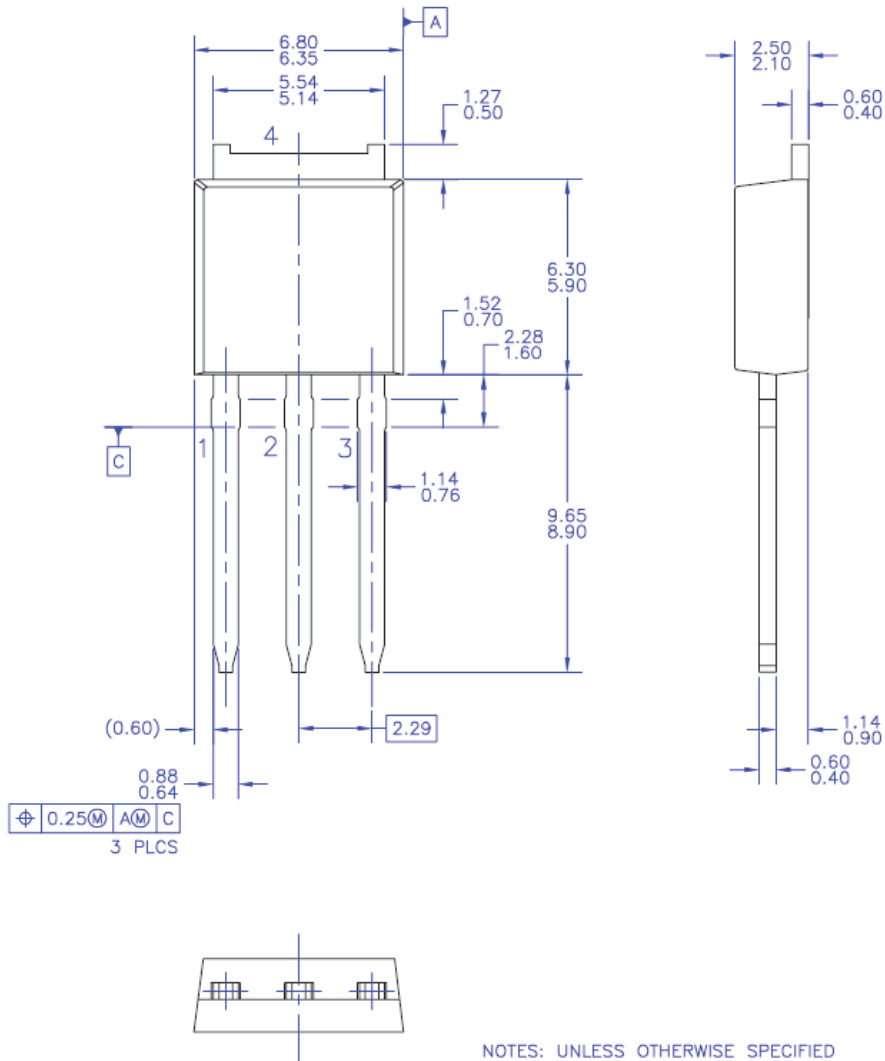
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## Mechanical Dimensions

### FQU13N06LTU\_WS



**Figure 18. TO-251 (I-PAK), Molded, 3-Lead, Option AA**

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| EfficientMax™            | MicroPak™                                       | SPM®                        | UHC®             |
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