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May 2014

# FDA24N40F

## N-Channel UniFET™ FRFET® MOSFET

400 V, 23 A, 190 mΩ

### Features

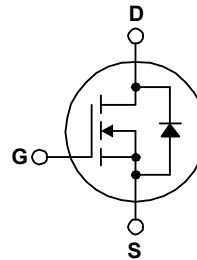
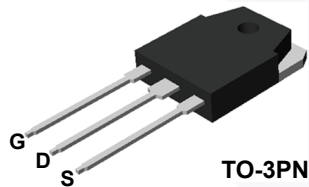
- $R_{DS(on)} = 150 \text{ m}\Omega$  (Typ.) @  $V_{GS} = 10 \text{ V}$ ,  $I_D = 11.5 \text{ A}$
- Low Gate Charge (Typ. 46 nC)
- Low  $C_{rss}$  (Typ. 25 pF)
- 100% Avalanche Tested
- RoHS Compliant

### Applications

- Uninterruptible Power Supply
- AC-DC Power Supply

### Description

UniFET™ MOSFET is Fairchild Semiconductor's high voltage MOSFET family based on planar stripe and DMOS technology. This MOSFET is tailored to reduce on-state resistance, and to provide better switching performance and higher avalanche energy strength. The body diode's reverse recovery performance of UniFET FRFET® MOSFET has been enhanced by lifetime control. Its trr is less than 100nsec and the reverse dv/dt immunity is 15V/ns while normal planar MOSFETs have over 200nsec and 4.5V/nsec respectively. Therefore, it can remove additional component and improve system reliability in certain applications in which the performance of MOSFET's body diode is significant. This device family is suitable for switching power converter applications such as power factor correction (PFC), flat panel display (FPD) TV power, ATX and electronic lamp ballasts.



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

Symbol	Parameter	FDA24N40F	Unit
$V_{DSS}$	Drain to Source Voltage	400	V
$V_{GSS}$	Gate to Source Voltage	±30	V
$I_D$	Drain Current	- Continuous ( $T_C = 25^\circ\text{C}$ )	23
		- Continuous ( $T_C = 100^\circ\text{C}$ )	13.8
$I_{DM}$	Drain Current	- Pulsed (Note 1)	92
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)	1190	mJ
$I_{AR}$	Avalanche Current (Note 1)	23	A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)	23.5	mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	4.5	V/ns
$P_D$	Power Dissipation ( $T_C = 25^\circ\text{C}$ )		235
		- Derate Above $25^\circ\text{C}$	1.8
$T_J, T_{STG}$	Operating and Storage Temperature Range	-55 to +150	$^\circ\text{C}$
$T_L$	Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds	300	$^\circ\text{C}$

### Thermal Characteristics

Symbol	Parameter	FDA24N40F	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case, Max.	0.53	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	40	

FDA24N40F — N-Channel UniFET™ FRFET® MOSFET

## Package Marking and Ordering Information

Part Number	Top Mark	Package	Packing Method	Reel Size	Tape Width	Quantity
FDA24N40F	FDA24N40F	TO-3PN	Tube	N/A	N/A	30 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 to Source Breakdown Voltage	$I_D = 250 \mu\text{A}$ , $V_{GS} = 0 \text{ V}$ , $T_J = 25^\circ\text{C}$	400	-	-	V
$\Delta BV_{DSS} / \Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D = 250 \mu\text{A}$ , Referenced to $25^\circ\text{C}$	-	0.5	-	$\text{V}/^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 400 \text{ V}$ , $V_{GS} = 0 \text{ V}$ $V_{DS} = 320 \text{ V}$ , $T_C = 125^\circ\text{C}$	-	-	10 100	$\mu\text{A}$
$I_{GSS}$	Gate to Body Leakage Current	$V_{GS} = \pm 30 \text{ V}$ , $V_{DS} = 0 \text{ V}$	-	-	$\pm 100$	nA

### On Characteristics

$V_{GS(th)}$	Gate Threshold Voltage	$V_{GS} = V_{DS}$ , $I_D = 250 \mu\text{A}$	3.0	-	5.0	V
$R_{DS(on)}$	Static Drain to Source On Resistance	$V_{GS} = 10 \text{ V}$ , $I_D = 11.5 \text{ A}$	-	0.15	0.19	$\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS} = 20 \text{ V}$ , $I_D = 11.5 \text{ A}$	-	29	-	S

### Dynamic Characteristics

$C_{iss}$	Input Capacitance	$V_{DS} = 25 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $f = 1 \text{ MHz}$	-	2280	3030	pF
$C_{oss}$	Output Capacitance		-	370	490	pF
$C_{rss}$	Reverse Transfer Capacitance		-	25	38	pF
$Q_{g(tot)}$	Total Gate Charge at 10V	$V_{DS} = 320 \text{ V}$ , $I_D = 23 \text{ A}$ , $V_{GS} = 10 \text{ V}$	-	46	60	nC
$Q_{gs}$	Gate to Source Gate Charge		-	13	-	nC
$Q_{gd}$	Gate to Drain "Miller" Charge		(Note 4)	-	18	-

### Switching Characteristics

$t_{d(on)}$	Turn-On Delay Time	$V_{DS} = 200 \text{ V}$ , $I_D = 23 \text{ A}$ , $V_{GS} = 10 \text{ V}$ , $R_G = 25 \Omega$	-	40	90	ns	
$t_r$	Turn-On Rise Time		-	92	195	ns	
$t_{d(off)}$	Turn-Off Delay Time		(Note 4)	-	120	250	ns
$t_f$	Turn-Off Fall Time		-	75	160	ns	

### Drain-Source Diode Characteristics

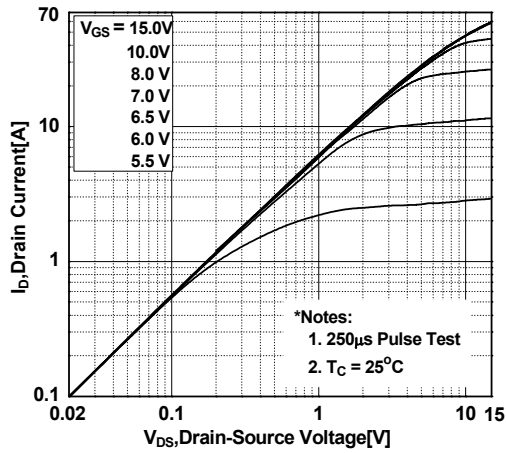
$I_S$	Maximum Continuous Drain to Source Diode Forward Current	-	-	23	A	
$I_{SM}$	Maximum Pulsed Drain to Source Diode Forward Current	-	-	92	A	
$V_{SD}$	Drain to Source Diode Forward Voltage	$V_{GS} = 0 \text{ V}$ , $I_{SD} = 23 \text{ A}$	-	-	1.5	V
$t_{rr}$	Reverse Recovery Time	$V_{GS} = 0 \text{ V}$ , $I_{SD} = 23 \text{ A}$ , $di_F/dt = 100 \text{ A}/\mu\text{s}$	-	110	-	ns
$Q_{rr}$	Reverse Recovery Charge		-	0.3	-	$\mu\text{C}$

#### Notes:

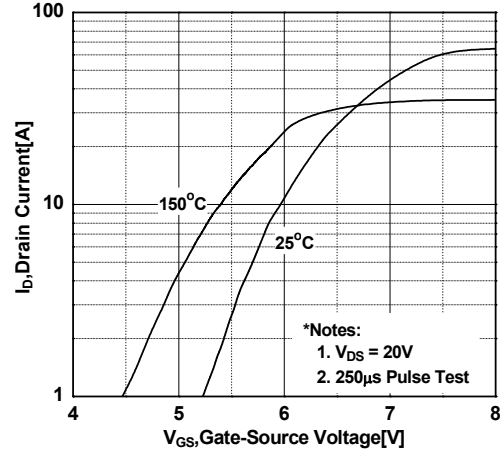
- 1: Repetitive rating: pulse-width limited by maximum junction temperature.
- 2:  $L = 4.5 \text{ mH}$ ,  $I_{AS} = 23 \text{ A}$ ,  $V_{DD} = 50 \text{ V}$ ,  $R_G = 25 \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
- 3:  $I_{SD} \leq 23 \text{ A}$ ,  $di/dt \leq 200 \text{ A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .
- 4: Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

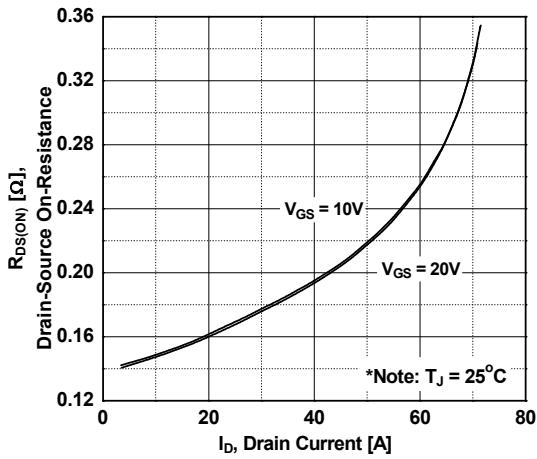
**Figure 1. On-Region Characteristics**



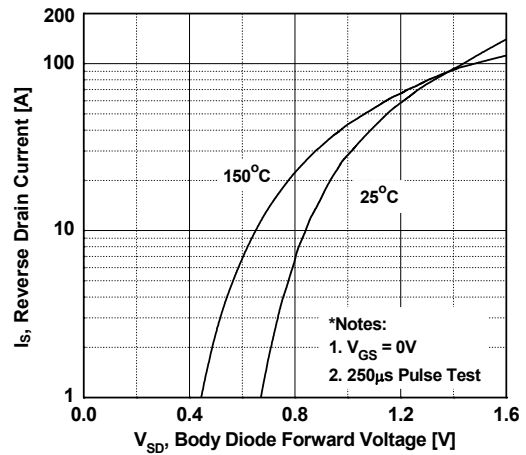
**Figure 2. Transfer Characteristics**



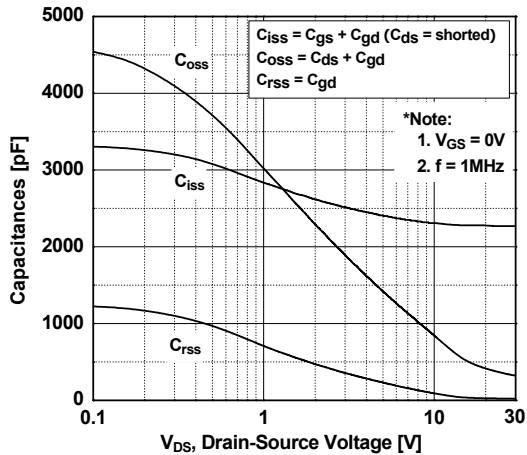
**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**



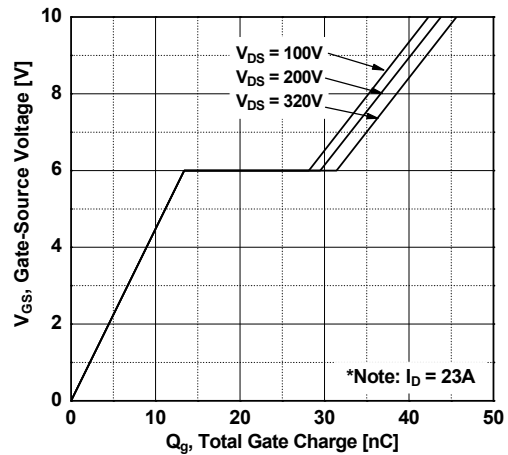
**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**



**Figure 5. Capacitance Characteristics**



**Figure 6. Gate Charge Characteristics**



Typical Performance Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

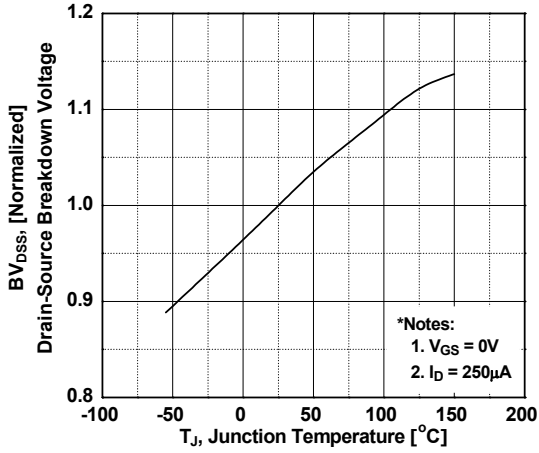


Figure 8. Maximum Safe Operating Area

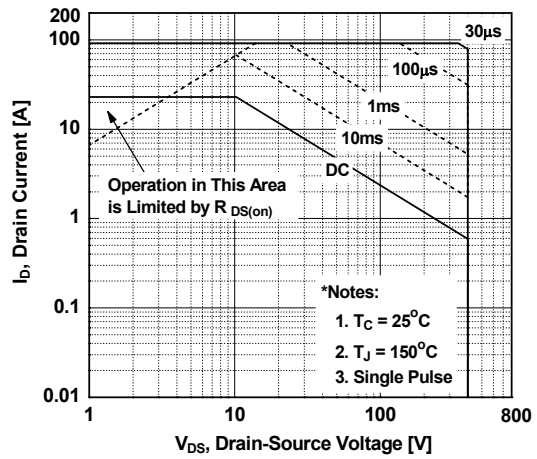


Figure 9. Maximum Drain Current vs. Case Temperature

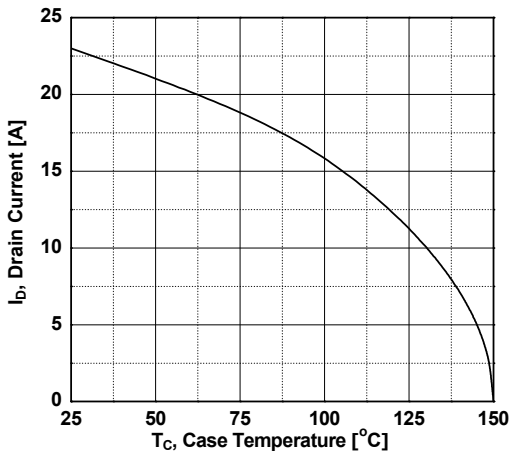
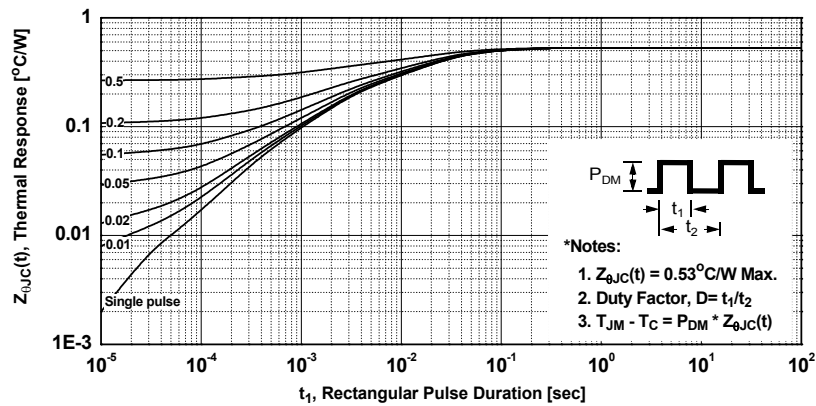


Figure 10. Transient Thermal Response Curve



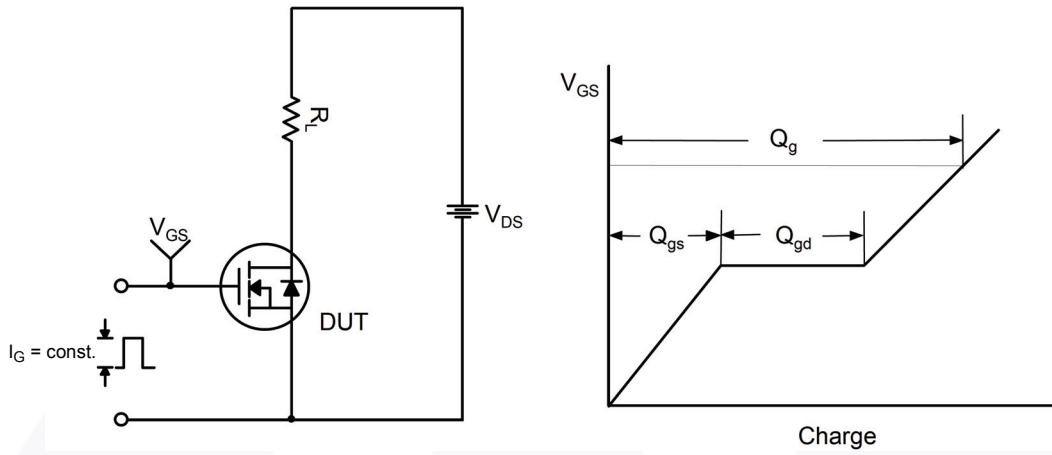


Figure 11. Gate Charge Test Circuit & Waveform



Figure 12. Resistive Switching Test Circuit & Waveforms

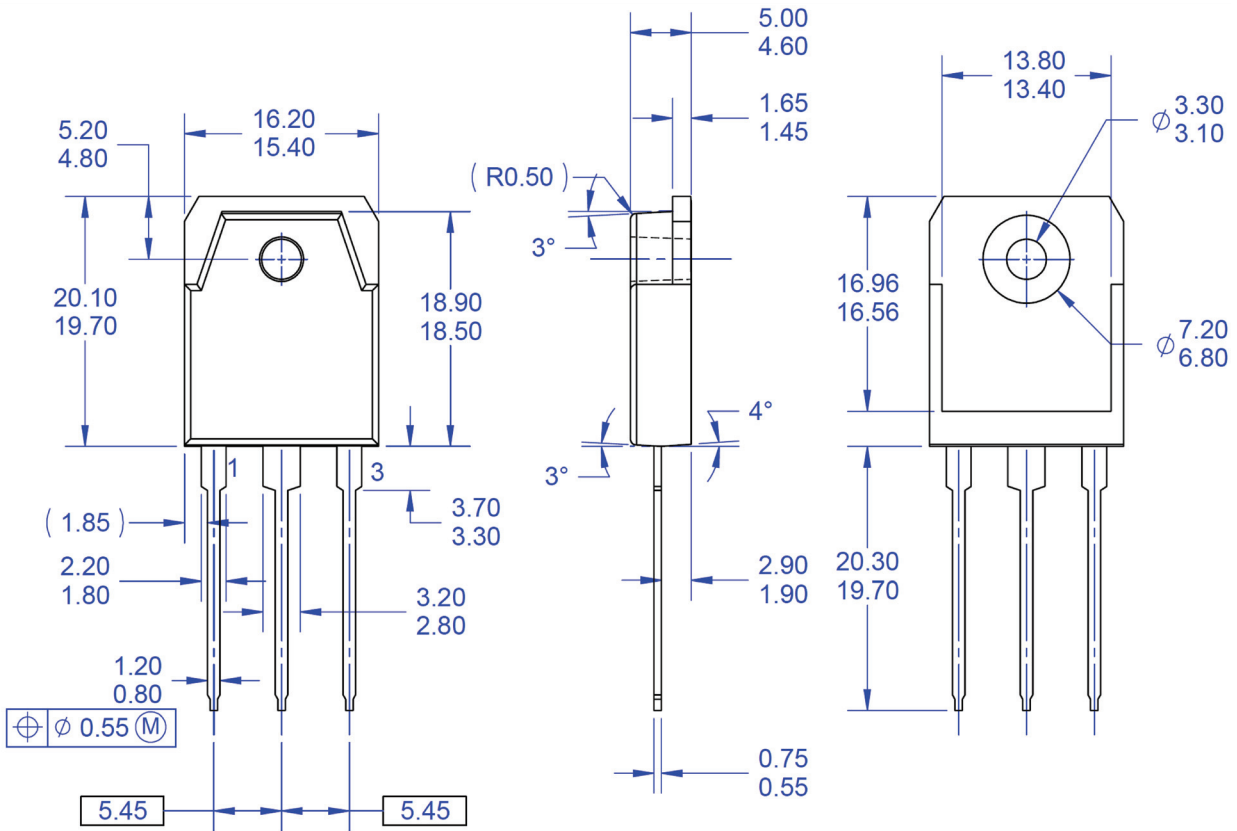


Figure 13. Unclamped Inductive Switching Test Circuit & Waveforms



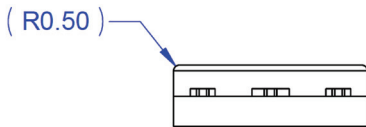
Figure 14. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms

### Mechanical Dimensions



NOTES: UNLESS OTHERWISE SPECIFIED

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- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSION AND TOLERANCING PER ASME14.5-2009.
- D) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- E) DRAWING FILE NAME: TO3PN03AREV1.
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**Figure 15. TO3PN, 3-Lead, Plastic, EIAJ SC-65**

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