

# MOSFET – N-Channel, UniFET™, FRFET®

500 V, 24 A, 200 mΩ

## FDA24N50F

### Description

UniFET MOSFET is onsemi'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 100 ns and the reverse dv/dt immunity is 15 V/ns while normal planar MOSFETs have over 200 ns and 4.5 V/ns 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.

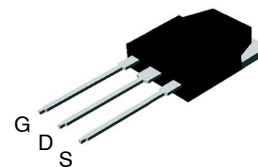
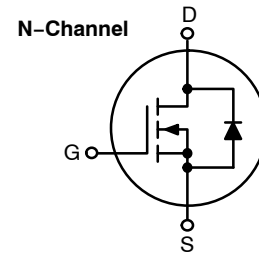
### Features

- $R_{DS(on)} = 166 \text{ m}\Omega$  (Typ.) @  $V_{GS} = 10 \text{ V}$ ,  $I_D = 12 \text{ A}$
- Low Gate Charge (Typ. 65 nC)
- Low  $C_{rss}$  (Typ. 32 pF)
- 100% Avalanche Tested
- Improved dv/dt Capability
- RoHS Compliant

### Applications

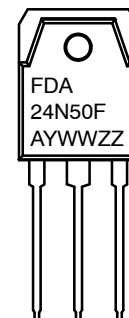
- PDP TV
- Uninterruptible Power Supply
- AC-DC Power Supply

| $V_{DS}$ | $R_{DS(on)}$ MAX | $I_D$ MAX |
|----------|------------------|-----------|
| 500 V    | 200 mΩ @ 10 V    | 24 A      |



TO-3P-3LD / EIAJ SC-65, ISOLATED  
CASE 340BZ

### MARKING DIAGRAM



FDA24N50F = Specific Device Code  
A = Assembly Site  
YWW = Date Code (Year & Work Week)  
ZZ = Assembly Lot Number

### ORDERING INFORMATION

| Device    | Package   | Shipping         |
|-----------|-----------|------------------|
| FDA24N50F | TO-3P-3LD | 450 Units / Tube |

# FDA24N50F

## MOSFET MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

| Symbol         | Parameter                                                            |                                            | Value       | Unit                |
|----------------|----------------------------------------------------------------------|--------------------------------------------|-------------|---------------------|
| $V_{DSS}$      | Drain to Source Voltage                                              |                                            | 500         | V                   |
| $V_{GSS}$      | Gate to Source Voltage                                               |                                            | $\pm 30$    | V                   |
| $I_D$          | Drain Current                                                        | - Continuous ( $T_C = 25^\circ\text{C}$ )  | 24          | A                   |
|                |                                                                      | - Continuous ( $T_C = 100^\circ\text{C}$ ) | 14          |                     |
|                |                                                                      | - Pulsed (Note 1)                          | 96          |                     |
| $I_{DM}$       |                                                                      |                                            |             |                     |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                              |                                            | 1872        | mJ                  |
| $I_{AR}$       | Avalanche Current (Note 1)                                           |                                            | 24          | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                 |                                            | 27          | mJ                  |
| $dv/dt$        | Peak Diode Recovery $dv/dt$ (Note 3)                                 |                                            | 20          | V/ns                |
| $P_D$          | Power Dissipation                                                    | $T_C = 25^\circ\text{C}$                   | 270         | W                   |
|                |                                                                      | -Derate above $= 25^\circ\text{C}$         | 2.2         | 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 5 Seconds |                                            | 300         | $^\circ\text{C}$    |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2.  $L = 6.5\text{ mH}$ ,  $I_{AS} = 24\text{ A}$ ,  $V_{DD} = 50\text{ V}$ ,  $R_G = 25\ \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 24\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .

## THERMAL CHARACTERISTICS

| Symbol          | Parameter                                     | Value | Unit                      |
|-----------------|-----------------------------------------------|-------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 0.46  | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 40    |                           |

# FDA24N50F

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise noted)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|--------|-----------|-----------------|-----|-----|-----|------|
|--------|-----------|-----------------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                      |                                           |                                                                       |     |     |      |      |
|--------------------------------------|-------------------------------------------|-----------------------------------------------------------------------|-----|-----|------|------|
| BV <sub>DSS</sub>                    | Drain to Source Breakdown Voltage         | I <sub>D</sub> = 250 μA, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 25°C | 500 | –   | –    | V    |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 250 μA, referenced to 25°C                           | –   | 0.6 | –    | V/°C |
| I <sub>DSS</sub>                     | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = 500 V, V <sub>GS</sub> = 0 V                        | –   | –   | 1    | μA   |
|                                      |                                           | V <sub>DS</sub> = 400 V, T <sub>C</sub> = 125°C                       | –   | –   | 10   |      |
| I <sub>GSS</sub>                     | Gate to Body Leakage Current              | V <sub>GS</sub> = ±30 V, V <sub>DS</sub> = 0 V                        | –   | –   | ±100 | nA   |

### ON CHARACTERISTICS

|                     |                                      |                                                             |     |       |       |   |
|---------------------|--------------------------------------|-------------------------------------------------------------|-----|-------|-------|---|
| V <sub>GS(th)</sub> | Gate Threshold Voltage               | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250 μA | 3.0 | –     | 5.0   | V |
| R <sub>DS(on)</sub> | Static Drain to Source On Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 12 A               | –   | 0.166 | 0.200 | Ω |
| g <sub>FS</sub>     | Forward Transconductance             | V <sub>DS</sub> = 20 V, I <sub>D</sub> = 12 A               | –   | 30    | –     | S |

### DYNAMIC CHARACTERISTICS

|                     |                               |                                                                                 |   |      |      |    |
|---------------------|-------------------------------|---------------------------------------------------------------------------------|---|------|------|----|
| C <sub>iss</sub>    | Input Capacitance             | V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V, f = 1 MHz                        | – | 3240 | 4310 | pF |
| C <sub>oss</sub>    | Output Capacitance            |                                                                                 | – | 450  | 600  | pF |
| C <sub>rss</sub>    | Reverse Transfer Capacitance  |                                                                                 | – | 32   | 48   | pF |
| Q <sub>g(tot)</sub> | Total Gate Charge at 10 V     | V <sub>DS</sub> = 400 V, I <sub>D</sub> = 24 A, V <sub>GS</sub> = 10 V (Note 4) | – | 65   | 85   | nC |
| Q <sub>gs</sub>     | Gate to Source Gate Charge    |                                                                                 | – | 18   | –    | nC |
| Q <sub>gd</sub>     | Gate to Drain “Miller” Charge |                                                                                 | – | 26   | –    | nC |

### SWITCHING CHARACTERISTICS

|                     |                     |                                                                                                        |   |     |     |    |
|---------------------|---------------------|--------------------------------------------------------------------------------------------------------|---|-----|-----|----|
| t <sub>d(on)</sub>  | Turn-On Delay Time  | V <sub>DD</sub> = 250 V, I <sub>D</sub> = 24 A, V <sub>GS</sub> = 10 V, R <sub>G</sub> = 25 Ω (Note 4) | – | 49  | 108 | ns |
| t <sub>r</sub>      | Turn-On Rise Time   |                                                                                                        | – | 105 | 220 | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time |                                                                                                        | – | 165 | 340 | ns |
| t <sub>f</sub>      | Turn-Off Fall Time  |                                                                                                        | – | 87  | 185 | ns |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|                 |                                                          |                                                                               |   |     |     |    |
|-----------------|----------------------------------------------------------|-------------------------------------------------------------------------------|---|-----|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain to Source Diode Forward Current |                                                                               | – | –   | 24  | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain to Source Diode Forward Current     |                                                                               | – | –   | 96  | A  |
| V <sub>SD</sub> | Drain to Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 24 A                                 | – | –   | 1.4 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 24 A, dI <sub>F</sub> /dt = 100 A/μs | – | 264 | –   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  |                                                                               | – | 1.4 | –   | μC |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. Essentially independent of operating temperature typical characteristics.

TYPICAL PERFORMANCE CHARACTERISTICS

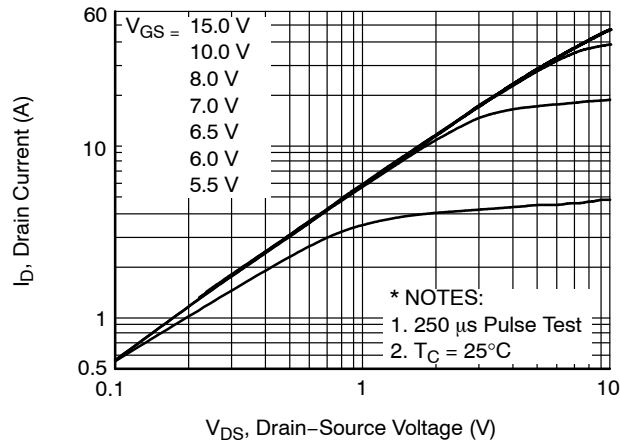


Figure 1. On-Region Characteristics

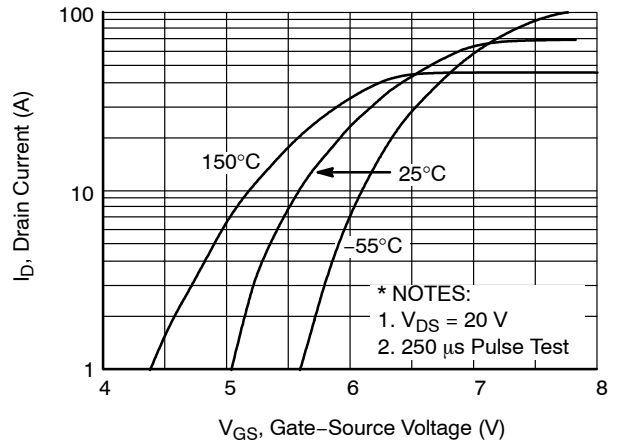


Figure 2. Transfer Characteristics

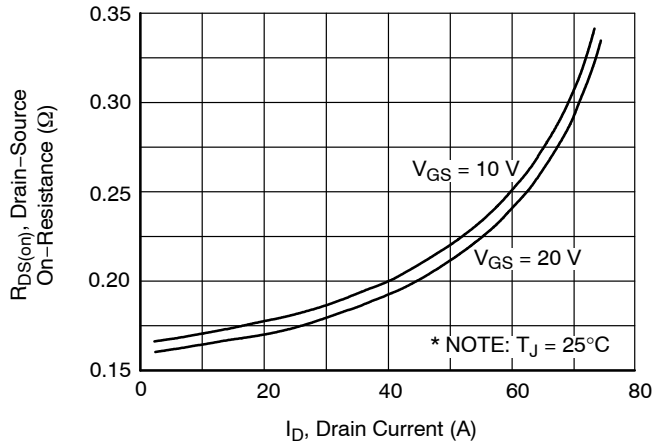


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

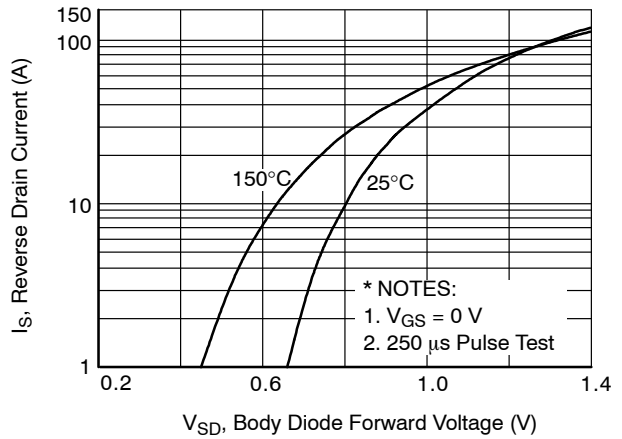


Figure 4. Body Diode Forward Voltage Variation vs. Source Current And Temperature

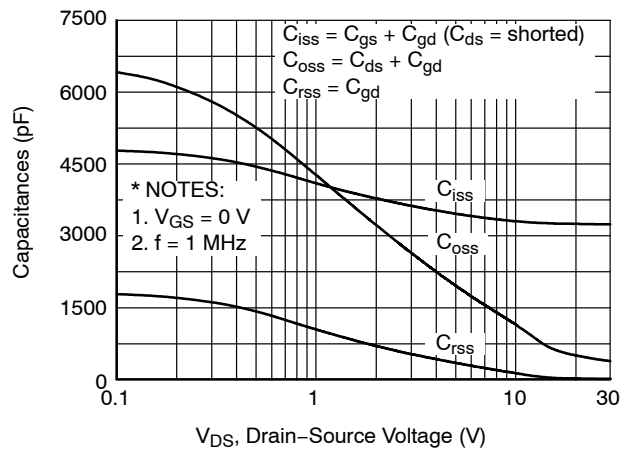


Figure 5. Capacitance Characteristics

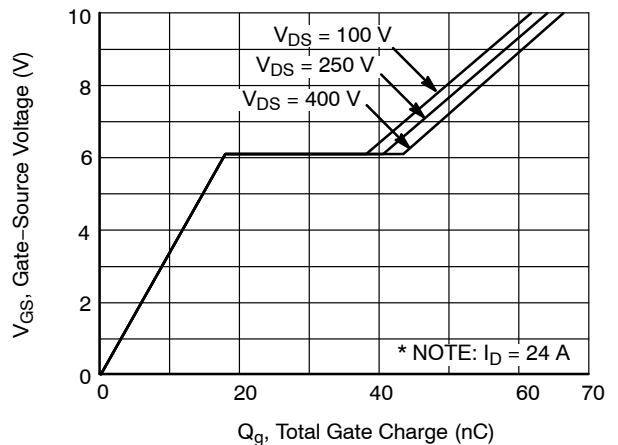


Figure 6. Gate Charge Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

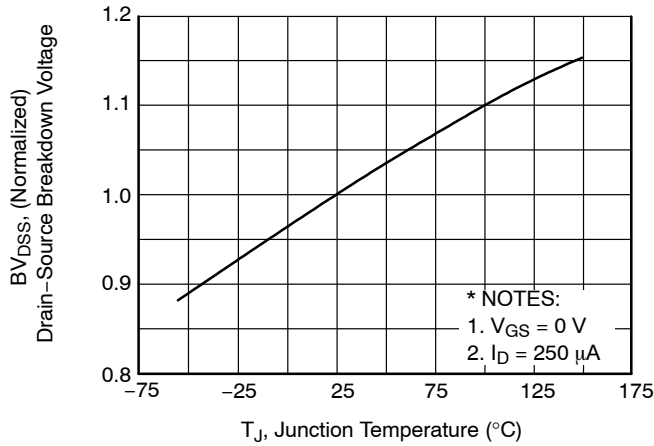


Figure 7. Breakdown Voltage Variation vs. Temperature

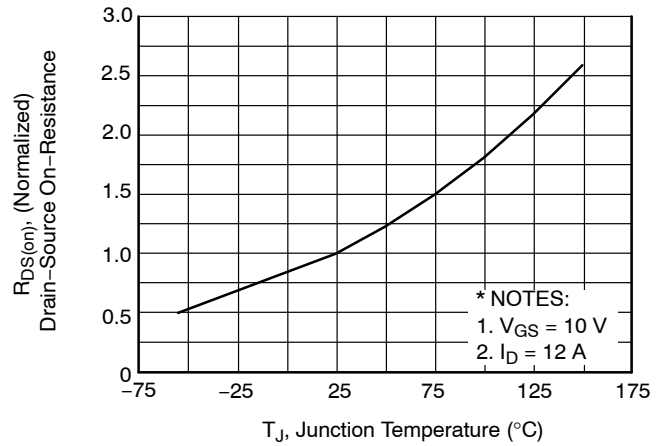


Figure 8. On-Resistance Variation vs. Temperature

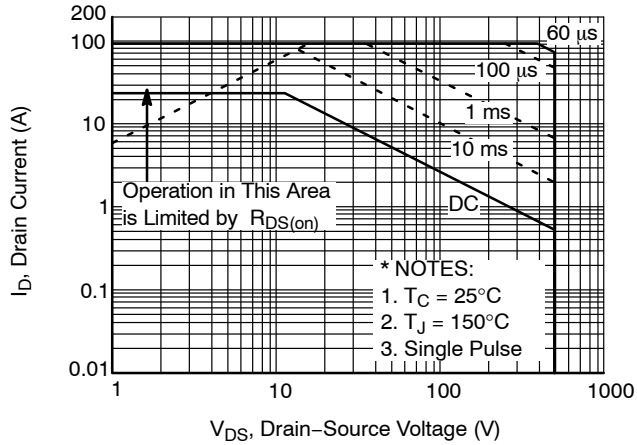


Figure 9. Maximum Safe Operating Area

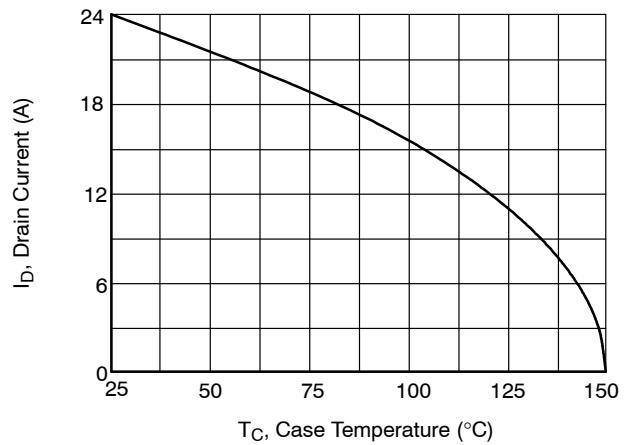


Figure 10. Maximum Drain Current vs. Case Temperature

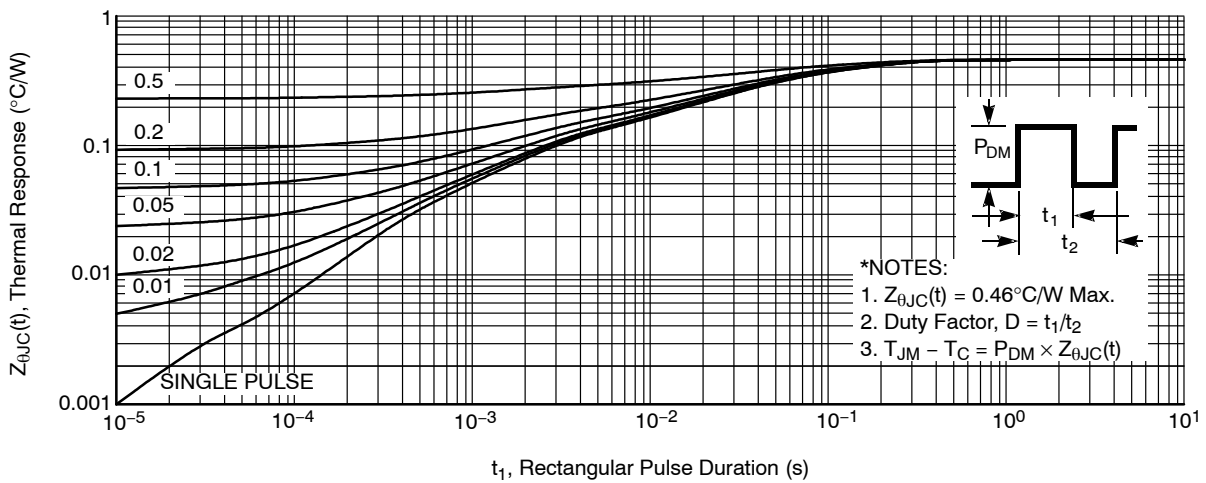


Figure 11. Transient Thermal Response Curve

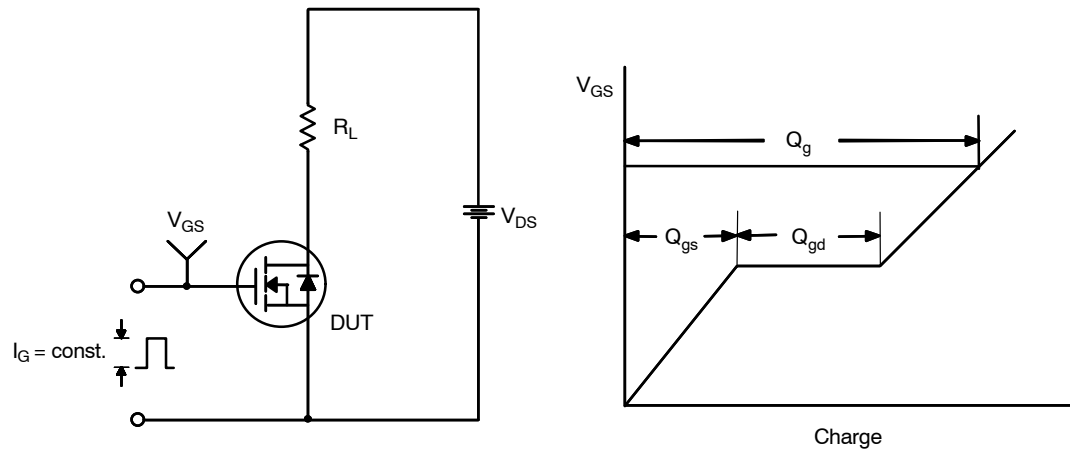


Figure 12. Gate Charge Test Circuit & Waveform

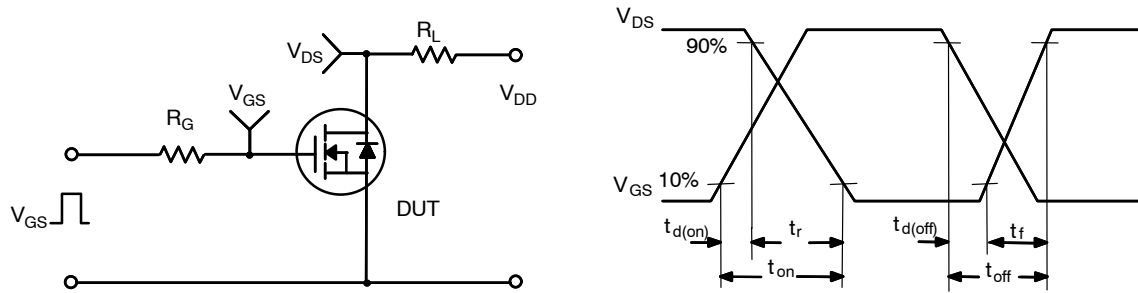


Figure 13. Resistive Switching Test Circuit & Waveforms

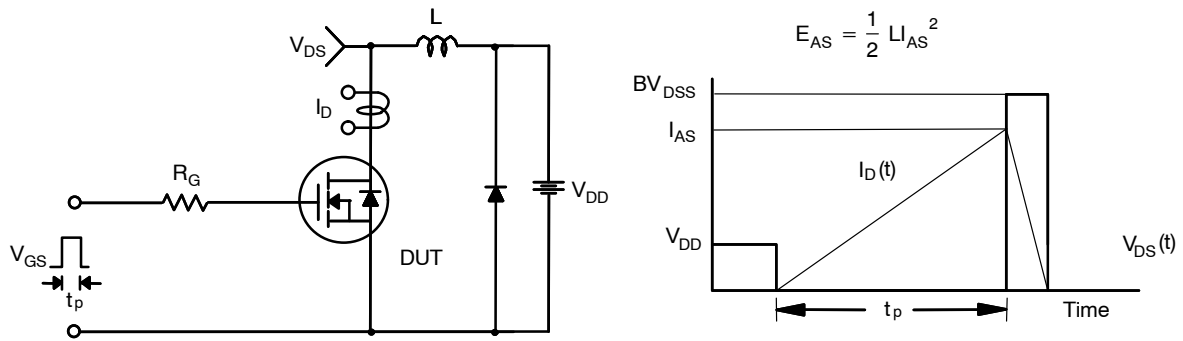
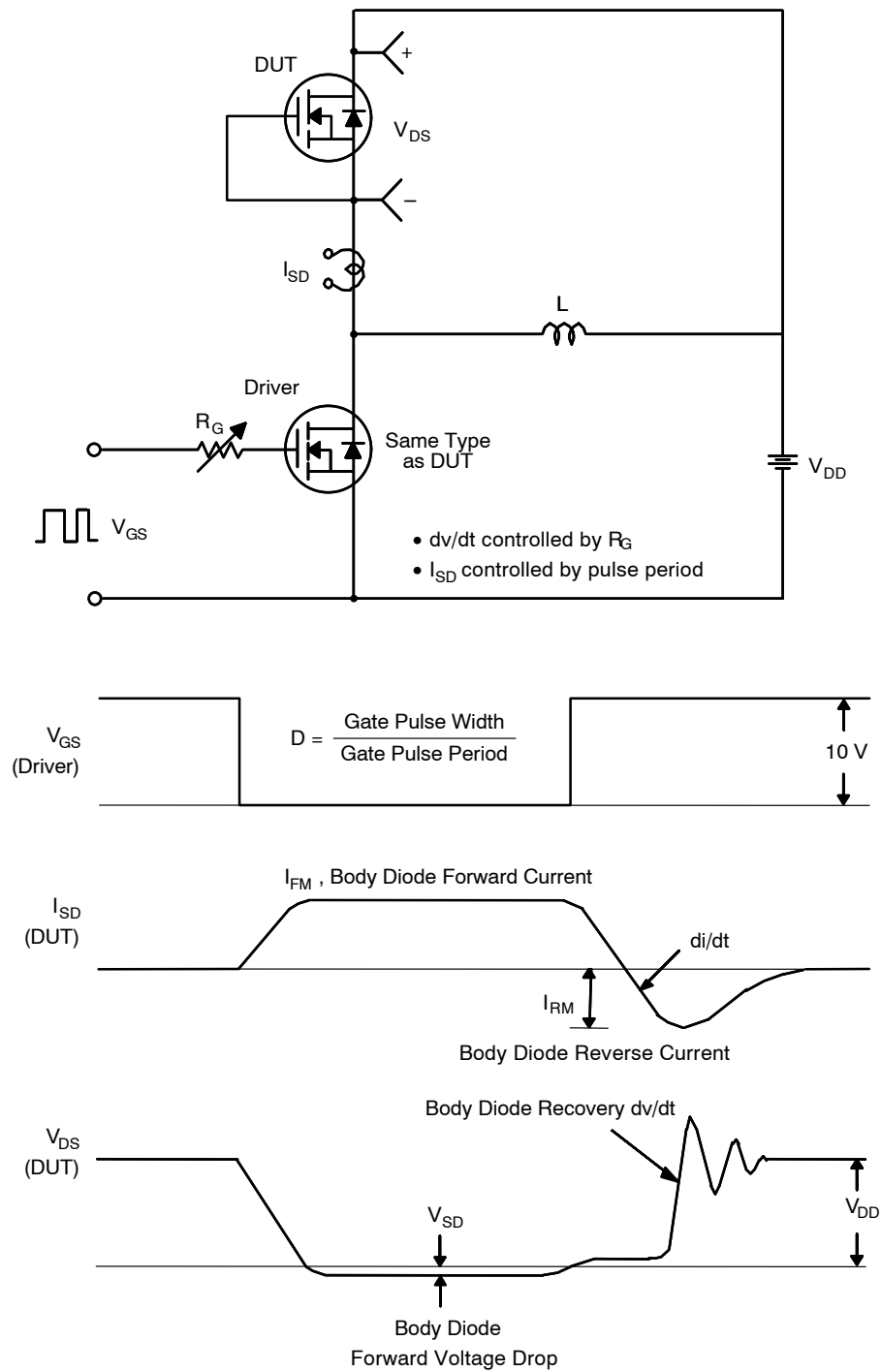


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms

## FDA24N50F



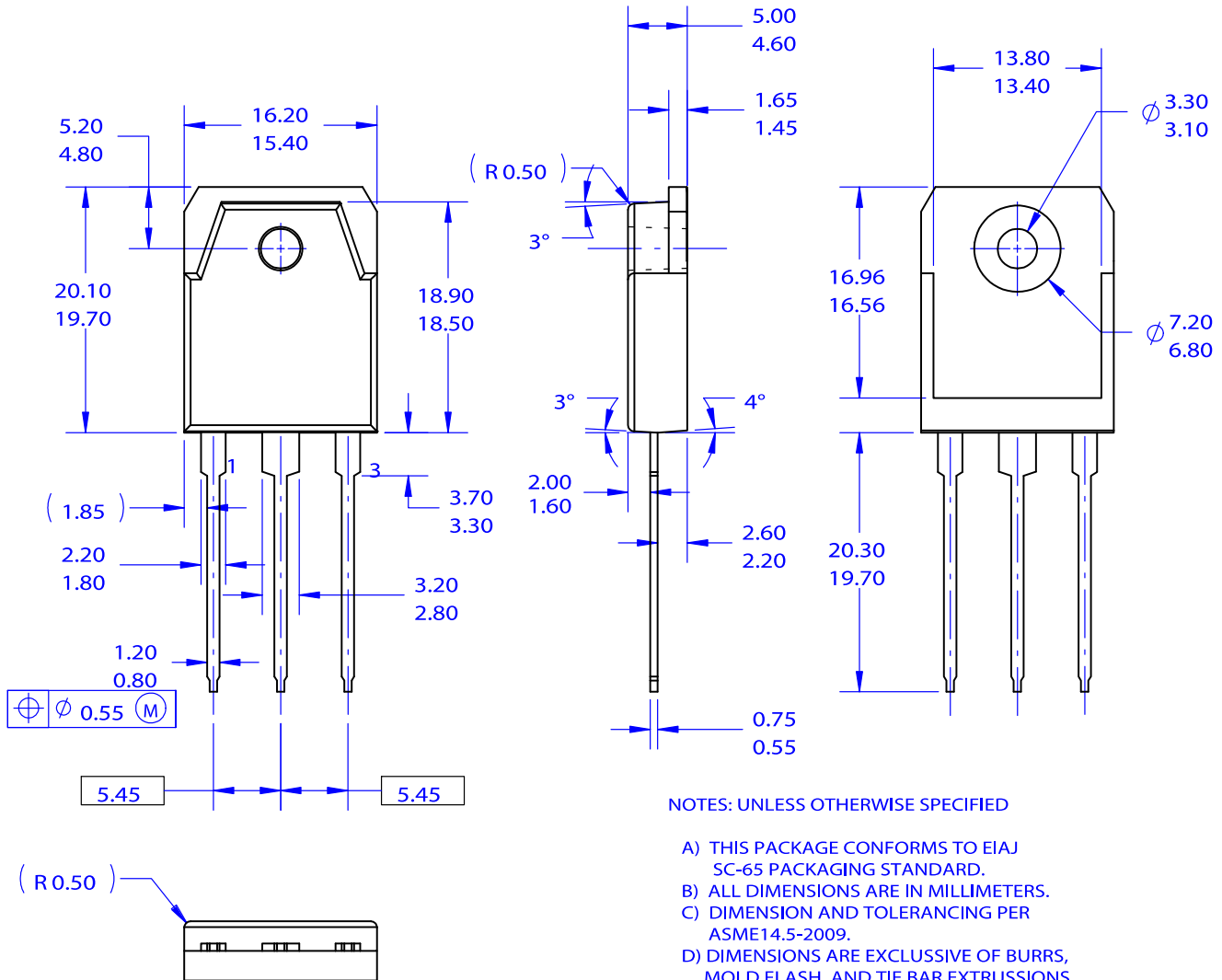
**Figure 15. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**

UniFET is a trademark of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries.

FRFET is a registered trademark of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries.

**TO-3P-3LD / EIAJ SC-65, ISOLATED**  
**CASE 340BZ**  
**ISSUE O**

DATE 31 OCT 2016



NOTES: UNLESS OTHERWISE SPECIFIED

- A) THIS PACKAGE CONFORMS TO EIAJ SC-65 PACKAGING STANDARD.
- 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.

|                         |                                         |                                                                                                                                                                                     |
|-------------------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DOCUMENT NUMBER:</b> | <b>98AON13862G</b>                      | Electronic versions are uncontrolled except when accessed directly from the Document Repository.<br>Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| <b>DESCRIPTION:</b>     | <b>TO-3P-3LD / EIAJ SC-65, ISOLATED</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                                  |

onsemi and Onsemi are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.



**onsemi**, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## ADDITIONAL INFORMATION

### TECHNICAL PUBLICATIONS:

Technical Library: [www.onsemi.com/design/resources/technical-documentation](http://www.onsemi.com/design/resources/technical-documentation)  
onsemi Website: [www.onsemi.com](http://www.onsemi.com)

### ONLINE SUPPORT: [www.onsemi.com/support](http://www.onsemi.com/support)

For additional information, please contact your local Sales Representative at  
[www.onsemi.com/support/sales](http://www.onsemi.com/support/sales)