

# MOSFET – N-Channel, UniFET™, FRFET®

400 V, 23 A, 190 mΩ

## FDA24N40F

### 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  $t_{rr}$  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.

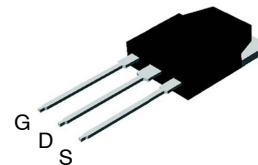
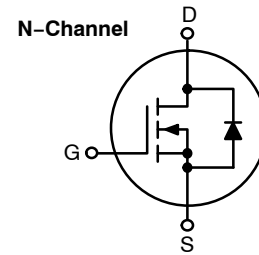
### Features

- $R_{DS(on)} = 150 \text{ m}\Omega$  (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

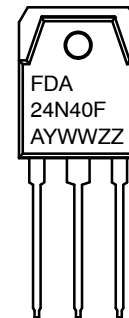
- Uninterruptible Power Supply
- AC-DC Power Supply

| $V_{DS}$ | $R_{DS(on)}$ MAX | $I_D$ MAX |
|----------|------------------|-----------|
| 400 V    | 190 mΩ @ 10 V    | 23 A      |



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

### MARKING DIAGRAM



FDA24N40F = Specific Device Code  
A = Assembly Site  
YWW = Date Code (Year & Work Week)  
ZZ = Assembly Lot Number

### ORDERING INFORMATION

| Device    | Package   | Shipping         |
|-----------|-----------|------------------|
| FDA24N40F | TO-3P-3LD | 450 Units / Tube |

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

| Symbol         | Parameter  | Value                                      | Unit             |
|----------------|--|--|------------------|
| $V_{DSS}$      | Drain to Source Voltage  | 400  | V                |
| $V_{GSS}$      | Gate to Source Voltage   | $\pm 30$                                   | V                |
| $I_D$          | Drain Current  | - Continuous ( $T_C = 25^\circ\text{C}$ )  | 23               |
|                |  | - Continuous ( $T_C = 100^\circ\text{C}$ ) | 13.8             |
|                |  | - Pulsed (Note 1)                          | 92               |
| $I_{DM}$       |  |  | A                |
| $E_{AS}$       | 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  | $^\circ\text{C}$ |

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.  $L = 4.5\text{ mH}$ ,  $I_{AS} = 23\text{ A}$ ,  $V_{DD} = 50\text{ V}$ ,  $R_G = 25\ \Omega$ , 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  $T_J = 25^\circ\text{C}$ .

## THERMAL CHARACTERISTICS

| Symbol          | Parameter                                     | Value | 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    |                           |

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## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

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

### 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                         |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | 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           | $V_{DS} = 400 \text{ V}$ , $V_{GS} = 0 \text{ V}$                           | –   | –   | 10        | $\mu\text{A}$             |
|                                      |   | $V_{DS} = 320 \text{ V}$ , $T_C = 125^\circ\text{C}$                        | –   | –   | 100       |                           |
| $I_{GSS}$                            | 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 10 V     | $V_{DS} = 320 \text{ V}$ , $I_D = 23 \text{ A}$ , $V_{GS} = 10 \text{ V}$<br>(Note 4) | – | 46   | 60   | nC |
| $Q_{gs}$     | Gate to Source Gate Charge    |   | – | 13   | –    | nC |
| $Q_{gd}$     | Gate to Drain "Miller" Charge |   | – | 18   | –    | nC |

### SWITCHING CHARACTERISTICS

|              |                     |   |   |     |     |    |
|--------------|---------------------|---|---|-----|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DS} = 200 \text{ V}$ , $I_D = 23 \text{ A}$ , $V_{GS} = 10 \text{ V}$ ,<br>$R_G = 25 \Omega$ (Note 4) | – | 40  | 90  | ns |
| $t_r$        | Turn-On Rise Time   |   | – | 92  | 195 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |   | – | 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 | –   | $\mu\text{C}$ |

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

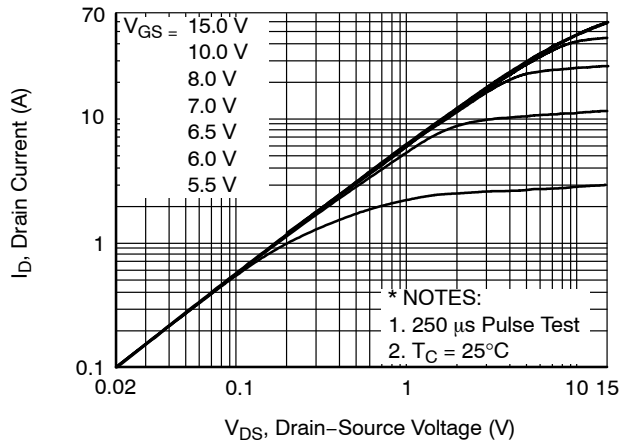


Figure 1. On-Region Characteristics

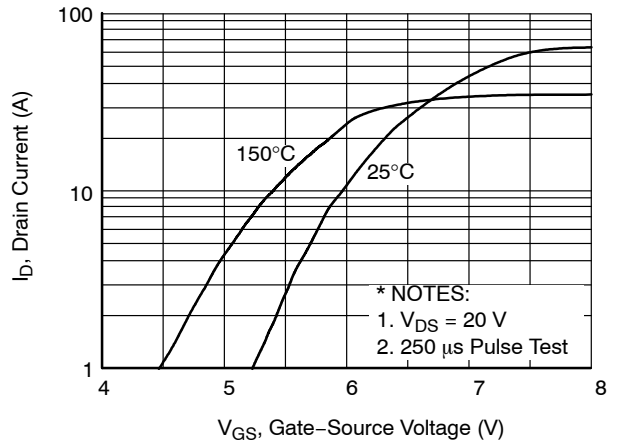


Figure 2. Transfer Characteristics

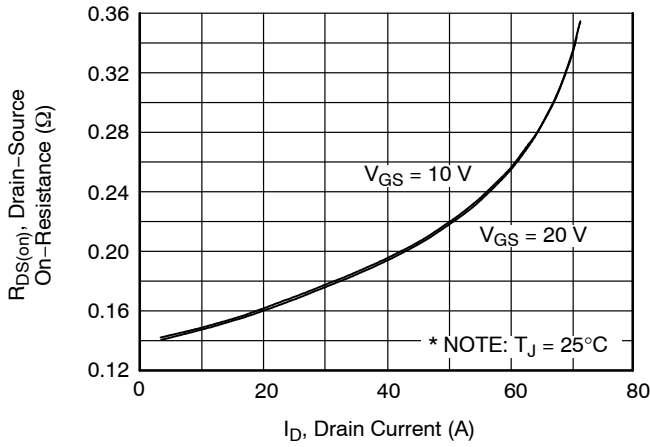


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

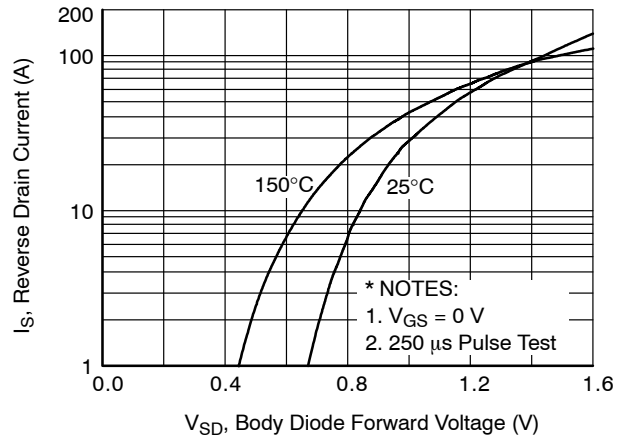


Figure 4. Body Diode Forward Voltage Variation vs. Source Current And Temperature

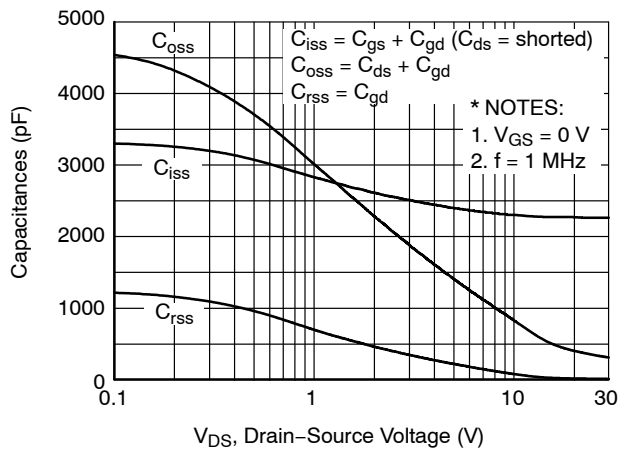


Figure 5. Capacitance Characteristics

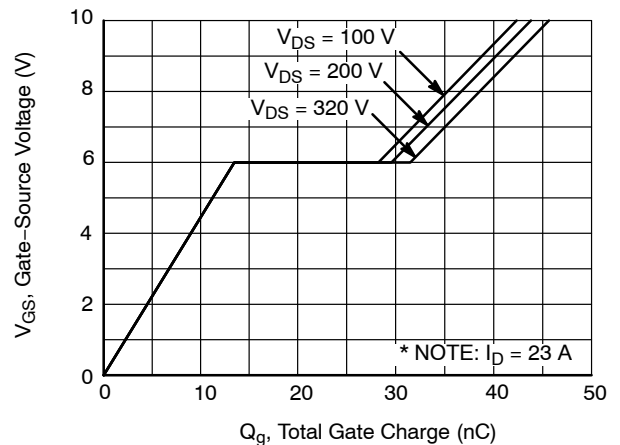


Figure 6. Gate Charge Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

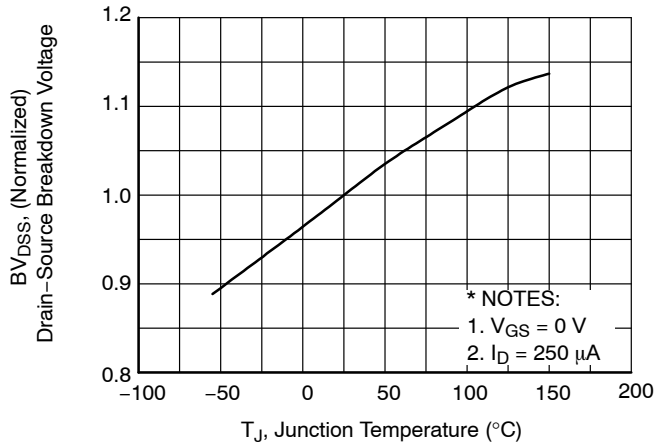


Figure 7. Breakdown Voltage Variation vs. Temperature

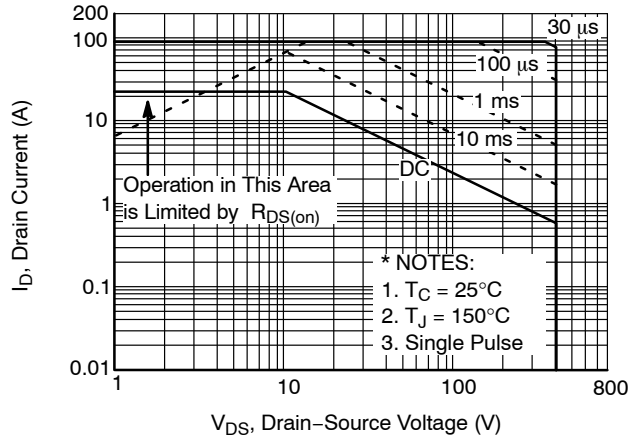


Figure 8. Maximum Safe Operating Area

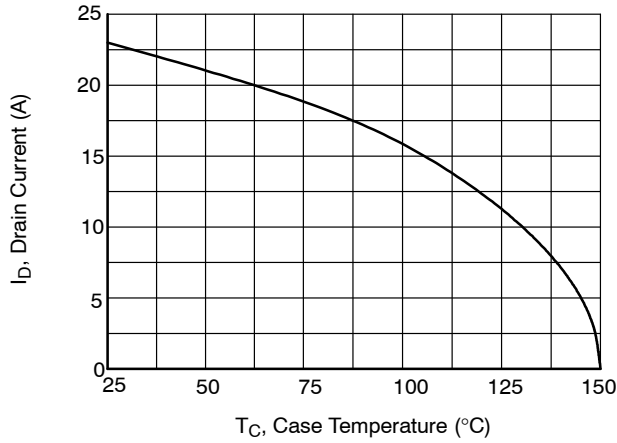


Figure 9. Maximum Drain Current vs. Case Temperature

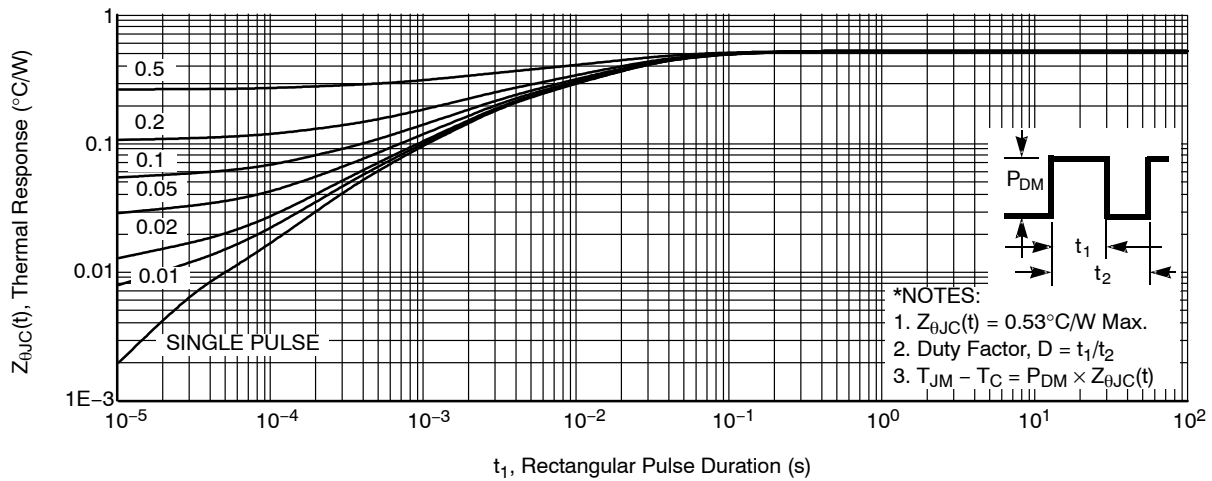


Figure 10. Transient Thermal Response Curve

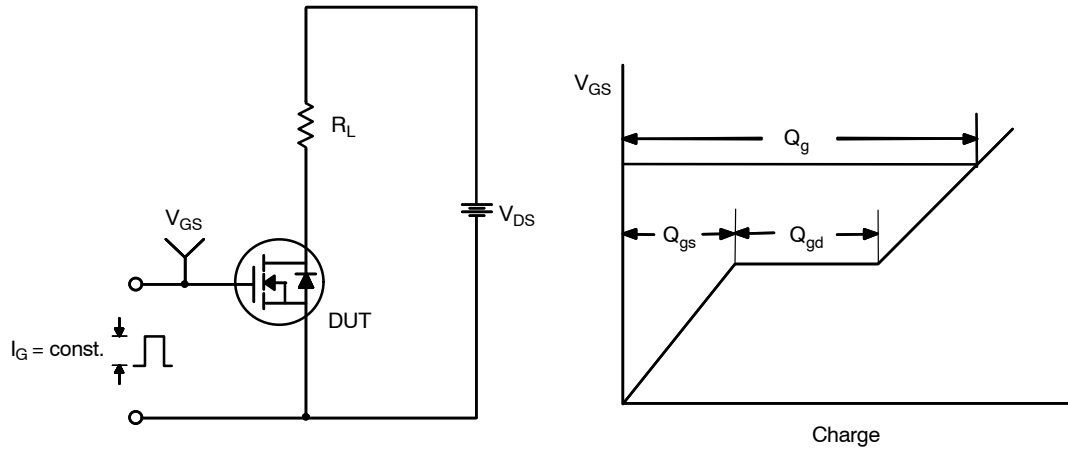


Figure 11. Gate Charge Test Circuit & Waveform

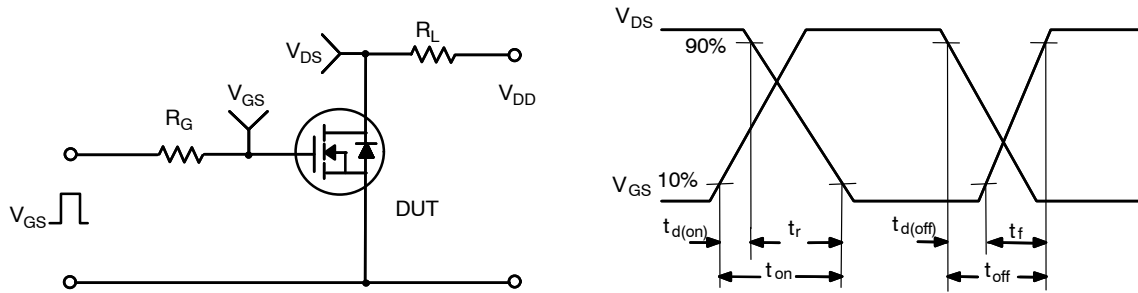


Figure 12. Resistive Switching Test Circuit & Waveforms

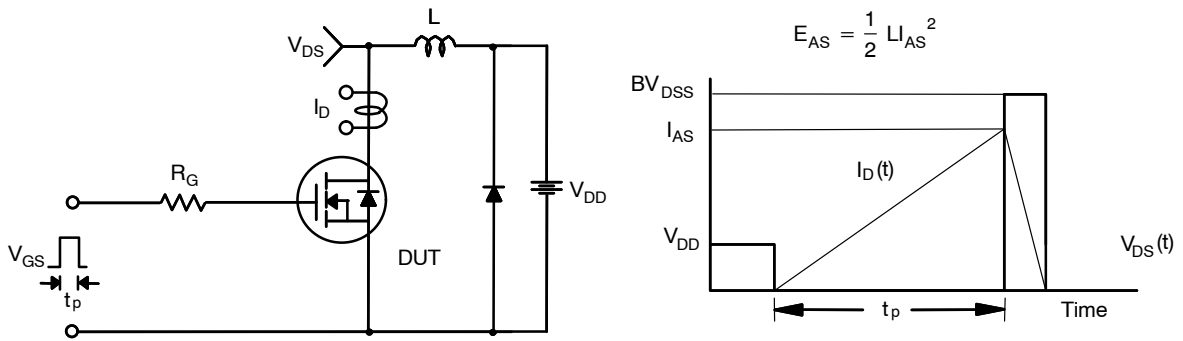
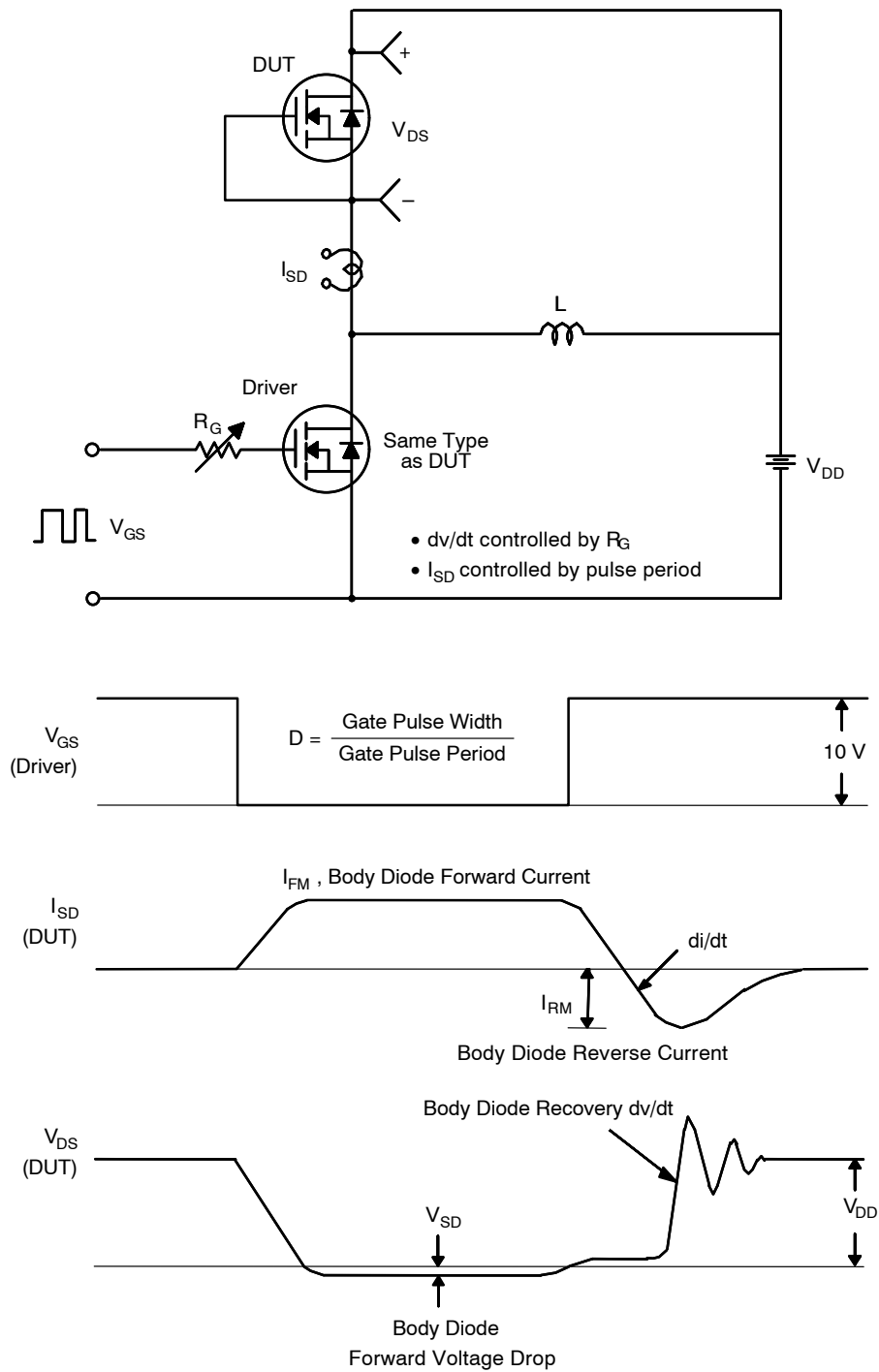


Figure 13. Unclamped Inductive Switching Test Circuit & Waveforms

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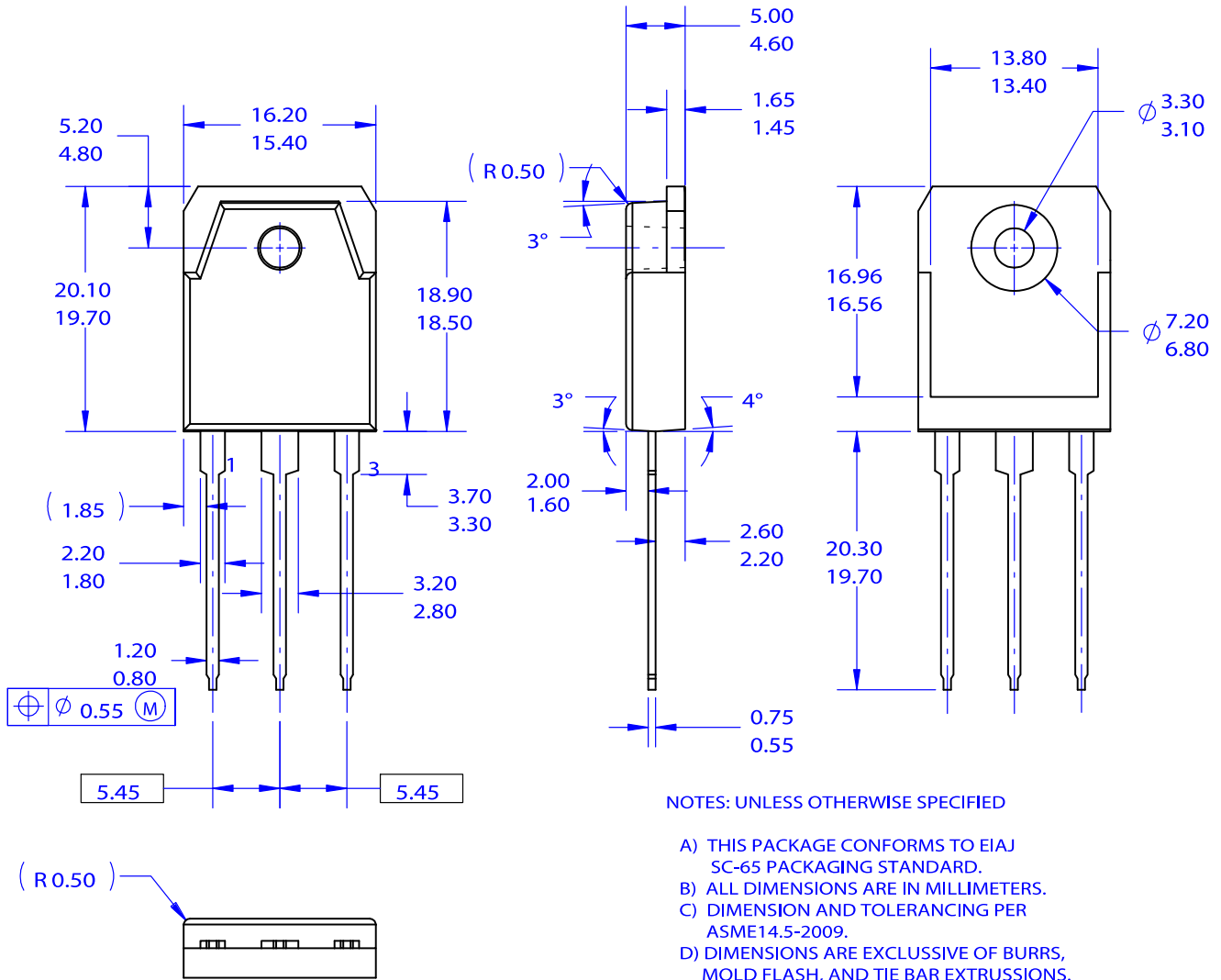
**Figure 14. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**

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

DATE 31 OCT 2016



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