

# FDA24N40F

## N-Channel UniFET™ FRFET® MOSFET

400 V, 23 A, 190 mΩ

### Features

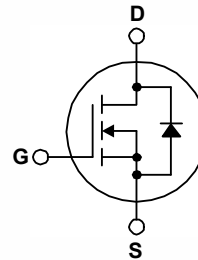
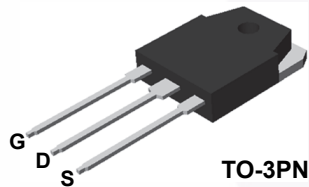
- $R_{DS(on)} = 150 \text{ m}\Omega$  (Typ.) @  $V_{GS} = 10 \text{ V}$ ,  $I_D = 11.5 \text{ A}$
- Low Gate Charge (Typ. 46 nC)
- Low  $C_{rss}$  (Typ. 25 pF)
- 100% Avalanche Tested
- RoHS Compliant

### 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        |                           |

## 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 |
|--------|-----------|-----------------|------|------|------|------|
|--------|-----------|-----------------|------|------|------|------|

### 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           | $V_{DS} = 400 \text{V}, V_{GS} = 0 \text{V}$<br>$V_{DS} = 320 \text{V}, T_C = 125^\circ\text{C}$ | -   | -   | 10<br>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             | $V_{DS} = 25 \text{V}, V_{GS} = 0 \text{V},$<br>$f = 1 \text{MHz}$    | -        | 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      | $V_{DS} = 320 \text{V}, I_D = 23 \text{A},$<br>$V_{GS} = 10 \text{V}$ | -        | 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  | $V_{DS} = 200 \text{V}, I_D = 23 \text{A},$<br>$V_{GS} = 10 \text{V}, R_G = 25 \Omega$ | -        | 40  | 90  | ns  |
| $t_r$        | Turn-On Rise Time   |  | -        | 92  | 195 | ns  |
| $t_{d(off)}$ | Turn-Off Delay Time |  | -        | 120 | 250 | ns  |
| $t_f$        | Turn-Off Fall Time  |  | (Note 4) | -   | 75  | 160 |

### Drain-Source Diode Characteristics

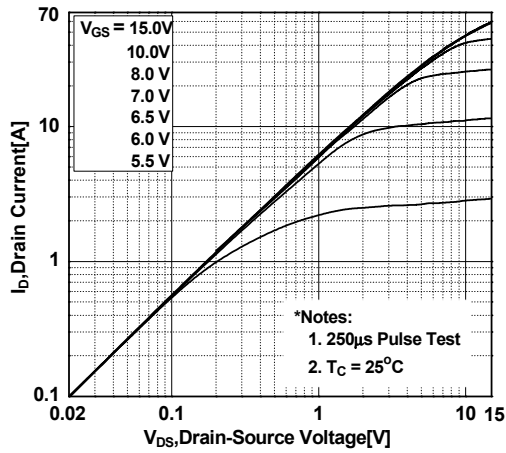
|          |  |  |   |     |     |               |
|----------|--|--|---|-----|-----|---------------|
| $I_S$    | Maximum Continuous Drain to Source Diode Forward Current | -  | - | 23  | A   |               |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current     | -  | - | 92  | A 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

#### Notes:

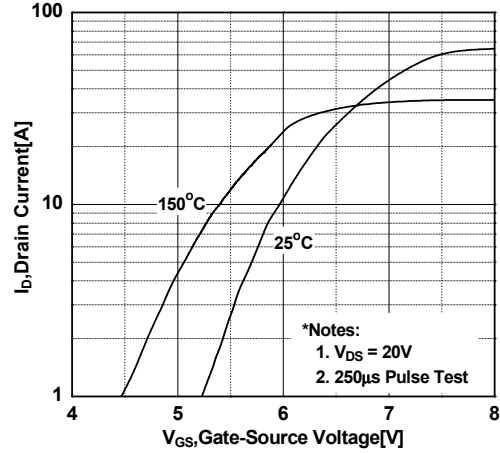
- 1: Repetitive rating: pulse-width limited by maximum junction temperature.
- 2:  $L = 4.5 \text{mH}, I_{AS} = 23 \text{A}, V_{DD} = 50 \text{V}, R_G = 25 \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
- 3:  $I_{SD} \leq 23 \text{A}, di/dt \leq 200 \text{A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , starting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

## Typical Performance Characteristics

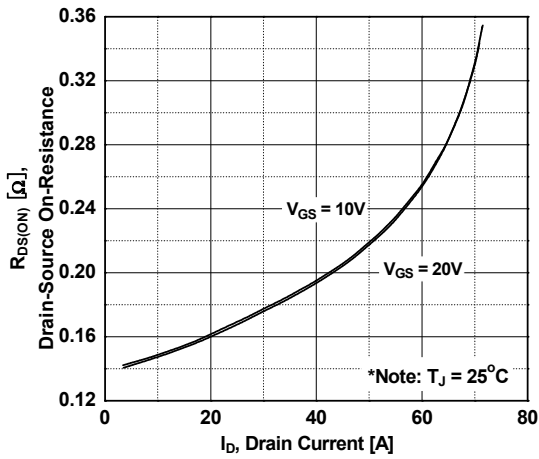
**Figure 1. On-Region Characteristics**



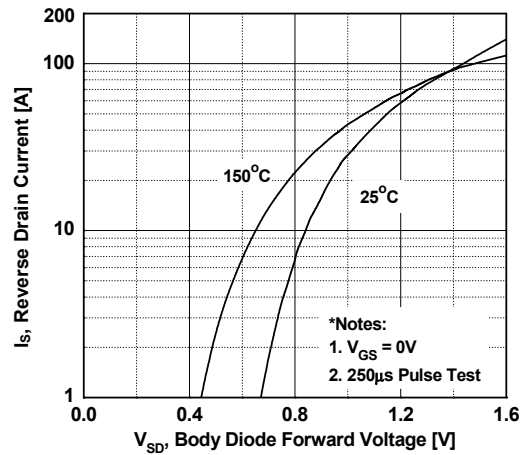
**Figure 2. Transfer Characteristics**



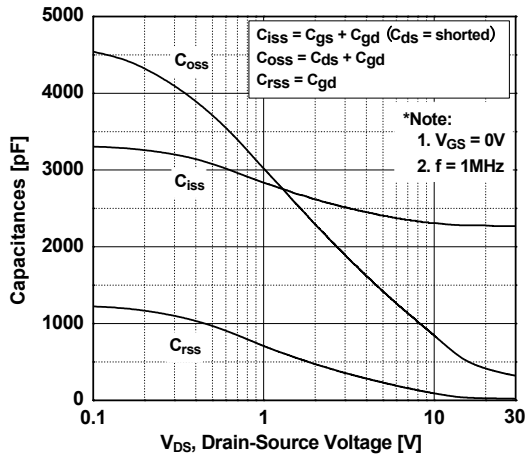
**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**



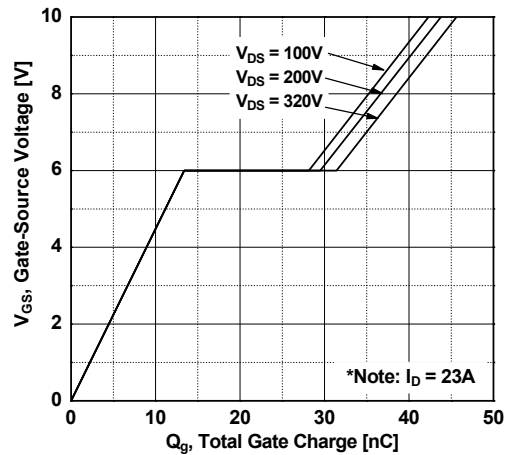
**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**



**Figure 5. Capacitance Characteristics**



**Figure 6. Gate Charge Characteristics**



Typical Performance Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

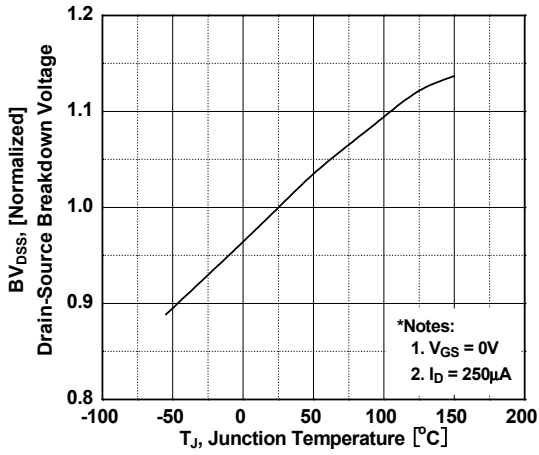


Figure 8. Maximum Safe Operating Area

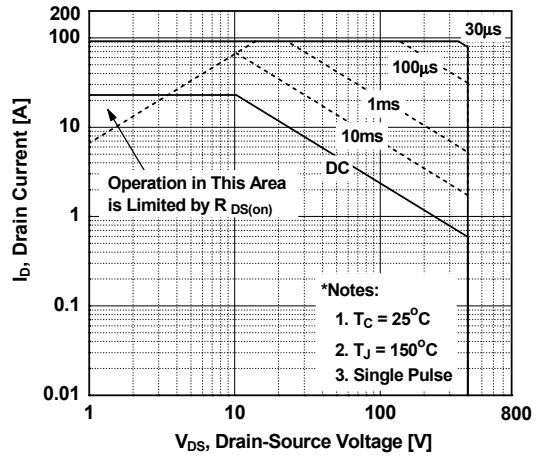


Figure 9. Maximum Drain Current vs. Case Temperature

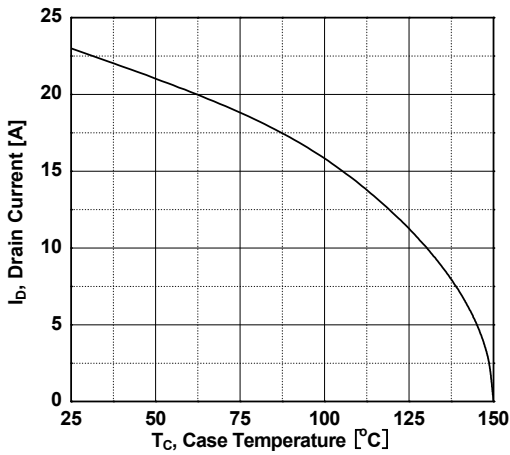


Figure 10. Transient Thermal Response Curve

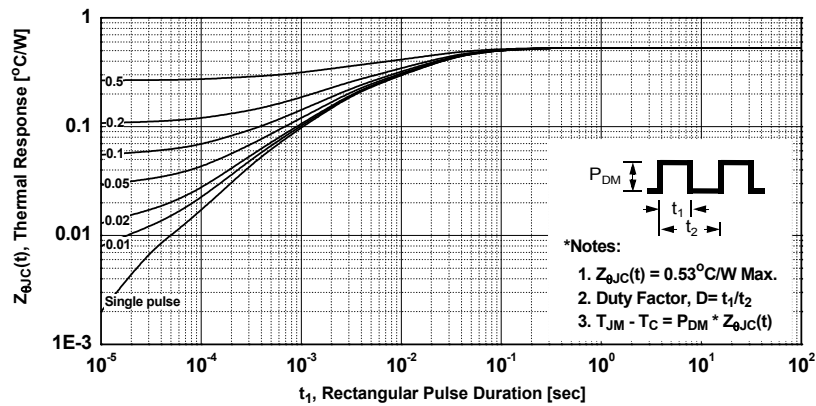




Figure 11. Gate Charge Test Circuit & Waveform



Figure 12. Resistive Switching Test Circuit & Waveforms



Figure 13. Unclamped Inductive Switching Test Circuit & Waveforms

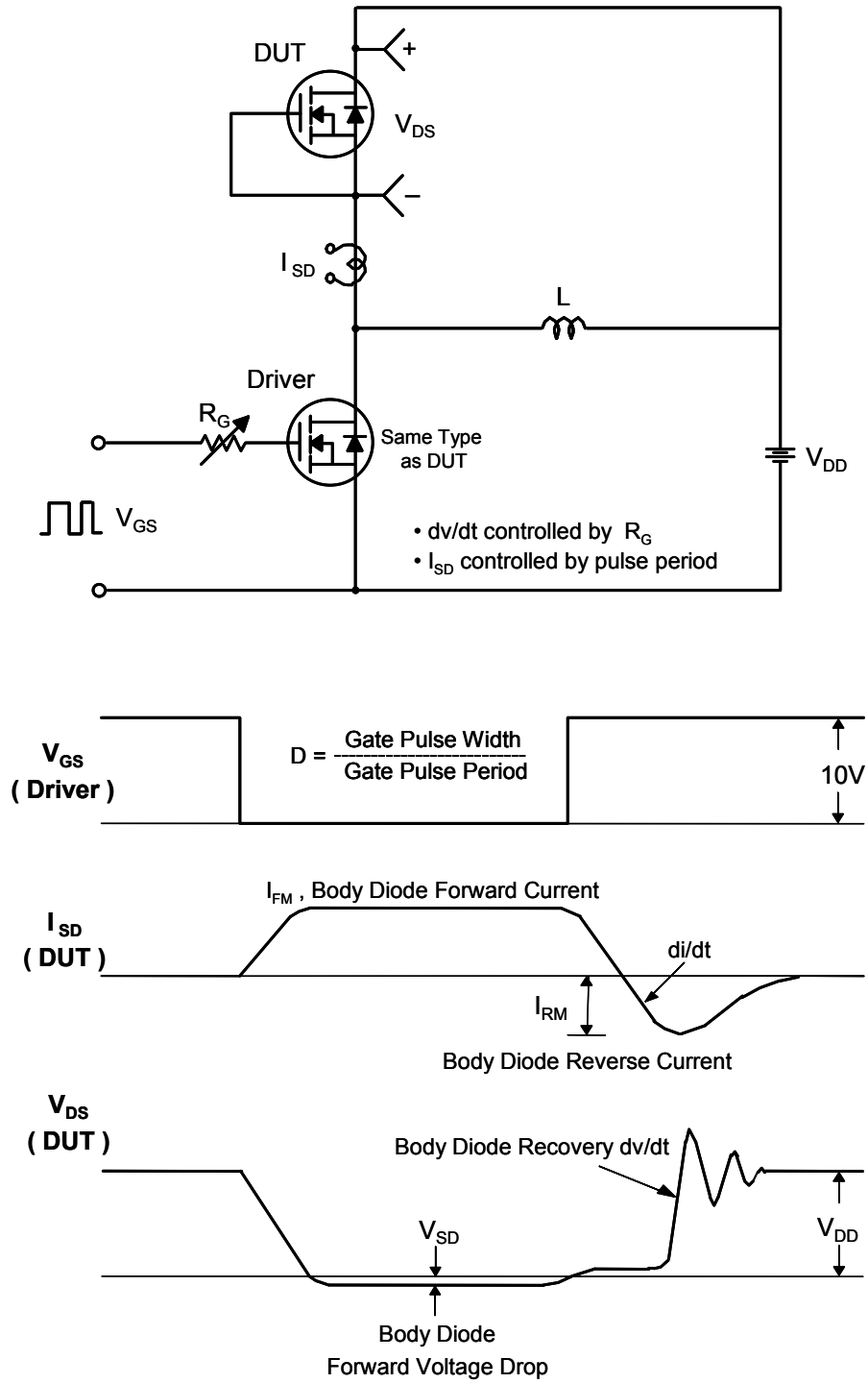
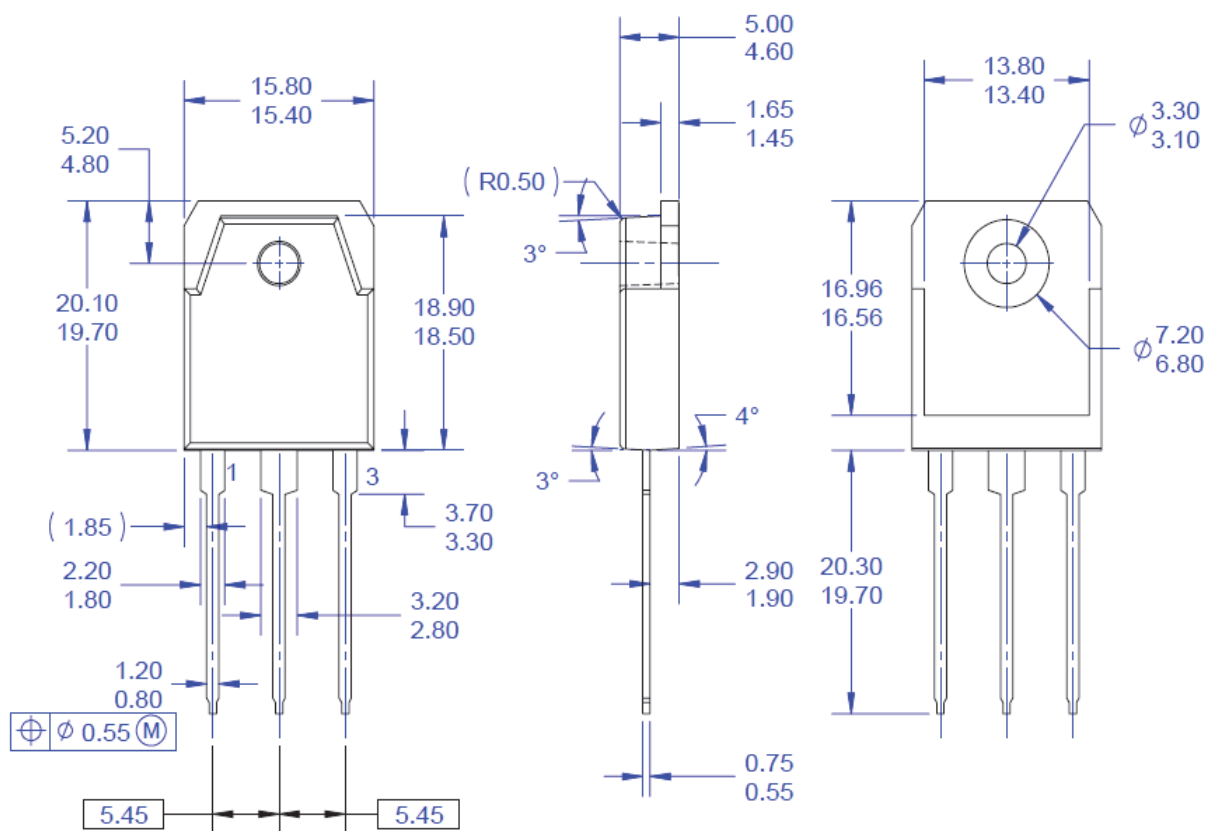


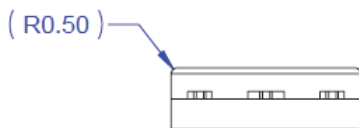
Figure 14. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms

## Mechanical Dimensions



NOTES: UNLESS OTHERWISE SPECIFIED

- A) THIS PACKAGE CONFORMS TO EIAJ SC-65 PACKAGING STANDARD.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSION AND TOLERANCING PER ASME14.5
- D) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- E) THIS PACKAGE IS INTENDED ONLY FOR T03PN.
- F) DRAWING FILE NAME: T03P03AREV4.



**Figure 15. TO3, 3-Lead, Plastic, EIAJ SC-65**

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| BitSiC™                  | Global Power ResourceSM | Programmable Active Droop™                      | TinyBoost®       |
| Build it Now™            | GreenBridge™            | QFET®   | TinyBuck®        |
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| EfficientMax™            | MillerDrive™            | MotionMax™                                      | TRUECURRENT®*    |
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| <b>F</b> ®               | OPTOPLANAR®             | OptoHiT™  | <b>µ</b> SerDes™ |
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| Fairchild Semiconductor® | STEALTH™                | OPTOLOGIC®                                      | Ultra FRFET™     |
| FACT Quiet Series™       | SuperFET®               | OPTOLOGIC®                                      | UniFET™          |
| FACT®                    | SuperSOT™-3             | OPTOLOGIC®                                      | VCX™             |
| FAST®                    | SuperSOT™-6             | OPTOLOGIC®                                      | VisualMax™       |
| FastvCore™               | SuperSOT™-8             | OPTOLOGIC®                                      | VoltagePlus™     |
| FETBench™                | SupreMOS®               | OPTOLOGIC®                                      | XS™              |
| FPS™                     | SyncFET™                | OPTOLOGIC®                                      |                  |

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