

# MOSFET – P-Channel, QFET -400 V, -1.56 A, 6.5 $\Omega$

## FQD2P40

### Description

This P-Channel enhancement mode power MOSFET is produced using onsemi'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.

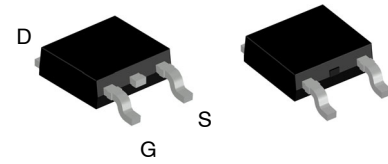
### Features

- -1.56 A, -400 V,  $R_{DS(on)} = 6.5 \Omega$  (Max.) @  $V_{GS} = -10$  V,  $I_D = -0.78$  A
- Low Gate Charge (Typ. 10 nC)
- Low  $C_{rss}$  (Typ. 6.5 pF)
- 100% Avalanche Tested
- RoHS Compliant

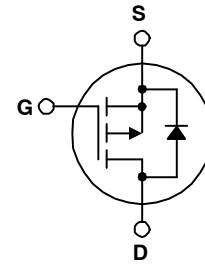
### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

| Symbol         | Parameter                                                                                                                              | Value            | Unit                          |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------------------------|
| $V_{DSS}$      | Drain-Source Voltage                                                                                                                   | -400             | V                             |
| $I_D$          | Drain Current<br>– Continuous ( $T_C = 25^\circ\text{C}$ )<br>– Continuous ( $T_C = 100^\circ\text{C}$ )                               | -1.56<br>-0.98   | A                             |
| $I_{DM}$       | Drain Current – Pulsed (Note 1)                                                                                                        | -6.24            | A                             |
| $V_{GSS}$      | Gate-Source Voltage                                                                                                                    | $\pm 30$         | V                             |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                                                                                | 120              | mJ                            |
| $I_{AR}$       | Avalanche Current (Note 1)                                                                                                             | -1.56            | A                             |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                                                                                   | 3.8              | mJ                            |
| $dv/dt$        | Peak Diode Recovery $dv/dt$ (Note 3)                                                                                                   | -4.5             | V/ns                          |
| $P_D$          | Power Dissipation ( $T_A = 25^\circ\text{C}$ )*<br>Power Dissipation ( $T_C = 25^\circ\text{C}$ )<br>– Derate above $25^\circ\text{C}$ | 2.5<br>38<br>0.3 | W<br>W<br>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 purposes, 1/8" from case for 5 seconds                                                          | 300              | $^\circ\text{C}$              |

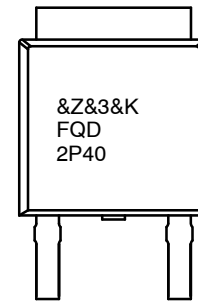
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.



DPAK3  
CASE 369AS



### MARKING DIAGRAM



&Z = Assembly Code  
&3 = Date Code (Year and Week)  
&K = Lot Code  
FQD2P40 = Specific Device Code

### ORDERING INFORMATION

| Device    | Package            | Shipping†              |
|-----------|--------------------|------------------------|
| FQD2P40TM | DPAK3<br>(Pb-Free) | 2,500 /<br>Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, [BRD8011/D](#).

# FQD2P40

## THERMAL CHARACTERISTICS

| Symbol          | Parameter                                                                  | Value | Unit |
|-----------------|----------------------------------------------------------------------------|-------|------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.                                 | 3.29  | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Minimum Pad of 2-oz Copper), Max. | 110   | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (*1 in2 Pad of 2-oz Copper), Max.  | 50    | °C/W |

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

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

### OFF CHARACTERISTICS

|                              |                                           |                                                                    |      |   |      |               |
|------------------------------|-------------------------------------------|--------------------------------------------------------------------|------|---|------|---------------|
| $BV_{DSS}$                   | Drain–Source Breakdown Voltage            | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$               | -400 | – | –    | V             |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = -250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$ | –    | – | –    | V/°C          |
| $I_{DSS}$                    | Zero Gate Voltage Drain Current           | $V_{DS} = -400\text{ V}, V_{GS} = 0\text{ V}$                      | –    | – | -1   | $\mu\text{A}$ |
|                              |                                           | $V_{DS} = -320\text{ V}, T_C = 125^\circ\text{C}$                  | –    | – | -10  | $\mu\text{A}$ |
| $I_{GSSF}$                   | Gate–Body Leakage Current, Forward        | $V_{GS} = -30\text{ V}, V_{DS} = 0\text{ V}$                       | –    | – | -100 | nA            |
| $I_{GSSR}$                   | Gate–Body Leakage Current, Reverse        | $V_{GS} = 30\text{ V}, V_{DS} = 0\text{ V}$                        | –    | – | 100  | nA            |

### ON CHARACTERISTICS

|              |                                   |                                                  |      |      |      |          |
|--------------|-----------------------------------|--------------------------------------------------|------|------|------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$ | -3.0 | –    | -5.0 | V        |
| $R_{DS(on)}$ | Static Drain–Source On–Resistance | $V_{GS} = -10\text{ V}, I_D = -0.78\text{ A}$    | –    | 5.0  | 6.5  | $\Omega$ |
| $g_{FS}$     | Forward Transconductance          | $V_{DS} = -50\text{ V}, I_D = -0.78\text{ A}$    | –    | 1.26 | –    | S        |

### DYNAMIC CHARACTERISTICS

|           |                              |                                                                       |   |     |     |    |
|-----------|------------------------------|-----------------------------------------------------------------------|---|-----|-----|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = -25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ | – | 270 | 350 | pF |
| $C_{oss}$ | Output Capacitance           |                                                                       | – | 45  | 60  | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                       | – | 6.5 | 8.5 | pF |

### SWITCHING CHARACTERISTICS

|              |                     |                                                                                        |   |     |    |    |
|--------------|---------------------|----------------------------------------------------------------------------------------|---|-----|----|----|
| $t_{d(on)}$  | Turn–On Delay Time  | $V_{DD} = -200\text{ V}, I_D = -2.0\text{ A},$<br>$R_G = 25\text{ }\Omega$<br>(Note 4) | – | 9   | 30 | ns |
| $t_r$        | Turn–On Rise Time   |                                                                                        | – | 33  | 75 | ns |
| $t_{d(off)}$ | Turn–Off Delay Time |                                                                                        | – | 22  | 55 | ns |
| $t_f$        | Turn–Off Fall Time  |                                                                                        | – | 25  | 60 | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = -320\text{ V}, I_D = -2.0\text{ A},$<br>$V_{GS} = -10\text{ V}$<br>(Note 4)  | – | 10  | 13 | nC |
| $Q_{gs}$     | Gate–Source Charge  |                                                                                        | – | 2.1 | –  | nC |
| $Q_{gd}$     | Gate–Drain Charge   |                                                                                        | – | 5.5 | –  | nC |

### DRAIN–SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

|                 |                                                       |                                                                                     |   |      |       |    |
|-----------------|-------------------------------------------------------|-------------------------------------------------------------------------------------|---|------|-------|----|
| I <sub>S</sub>  | Maximum Continuous Drain–Source Diode Forward Current |                                                                                     | – | –    | –1.56 | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain–Source Diode Forward Current     |                                                                                     | – | –    | –6.24 | A  |
| V <sub>SD</sub> | Drain–Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = –1.56 A                                     | – | –    | –5.0  | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = –2.0 A,<br>dI <sub>F</sub> / dt = 100 A/ μs | – | 250  | –     | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                               |                                                                                     | – | 0.85 | –     | 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.

#### NOTES:

1. Repetitive Rating: Pulse–width limited by maximum junction temperature.
2.  $L = 86\text{ mH}$ ,  $I_{AS} = -1.56\text{ A}$ ,  $V_{DD} = -50\text{ V}$ ,  $R_G = 25\text{ }\Omega$ , Starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq -2.0\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature.

TYPICAL CHARACTERISTICS

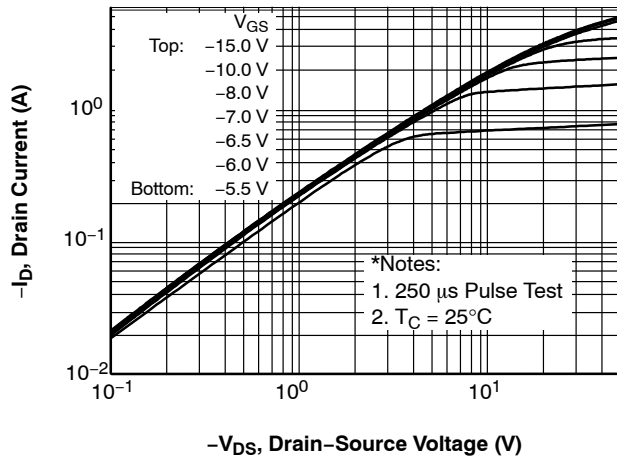


Figure 1. On-Region Characteristics

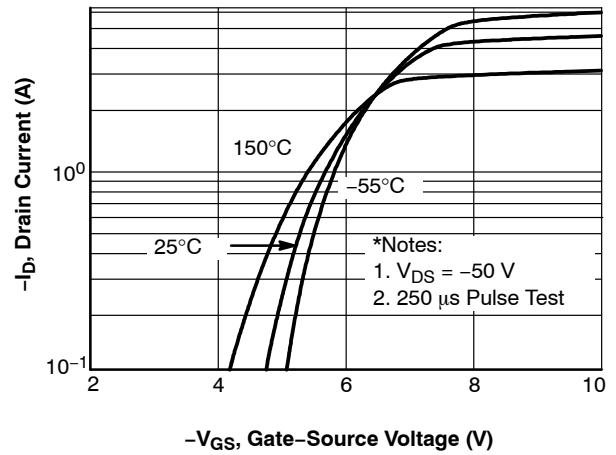


Figure 2. Transfer Characteristics

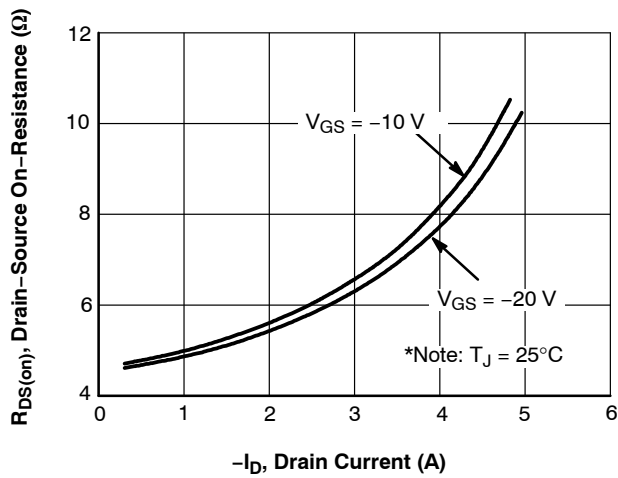


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

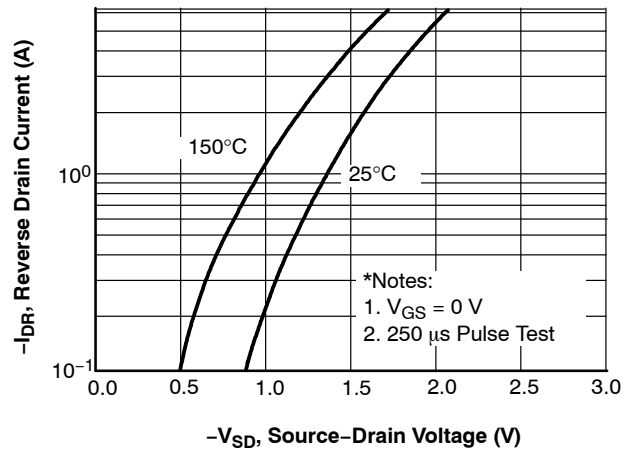


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

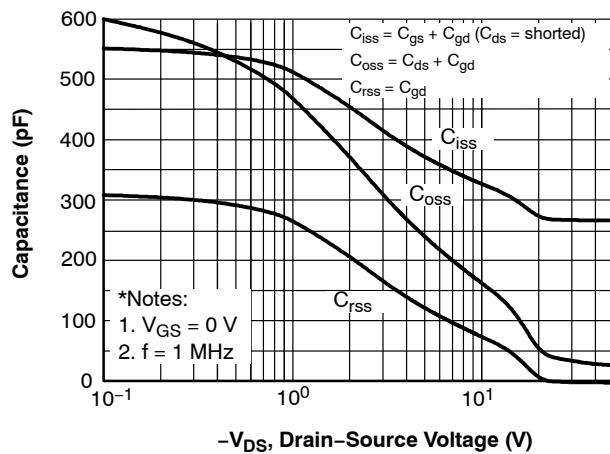


Figure 5. Capacitance Characteristics

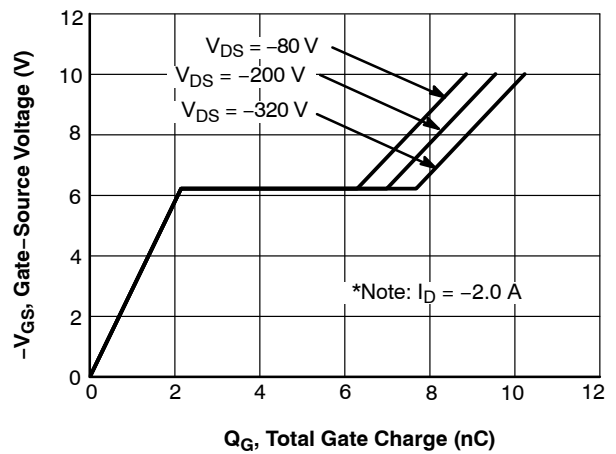


Figure 6. Gate Charge Characteristics

TYPICAL CHARACTERISTICS (continued)

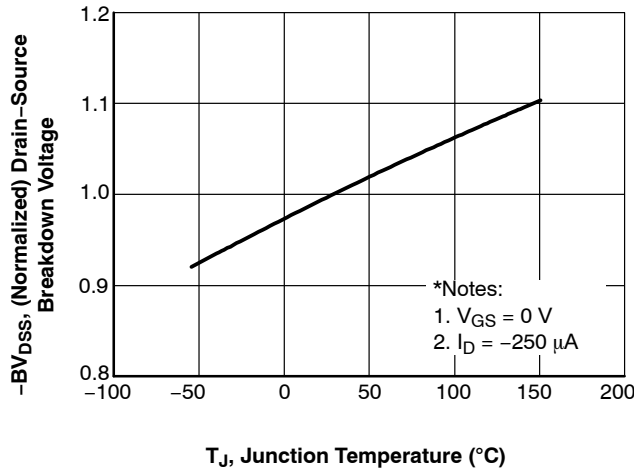


Figure 7. Breakdown Voltage Variation vs. Temperature

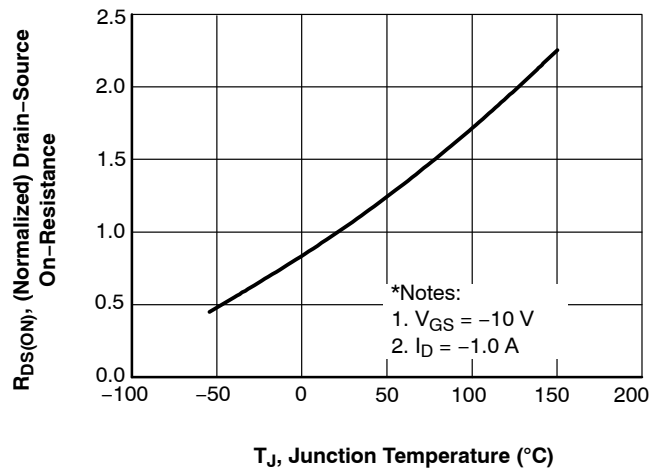


Figure 8. On-Resistance Variation vs. Temperature

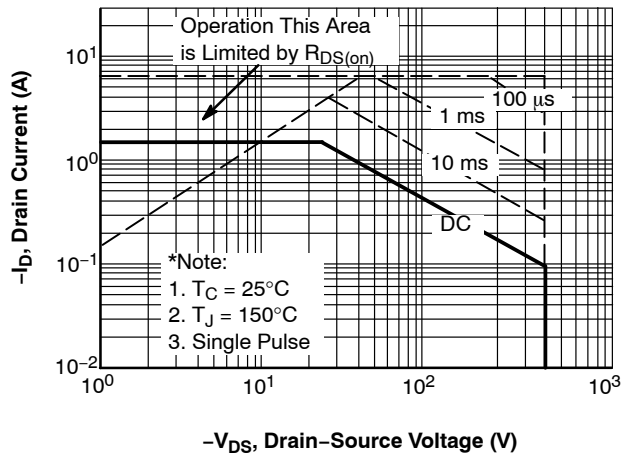


Figure 9. Maximum Safe Operating Area

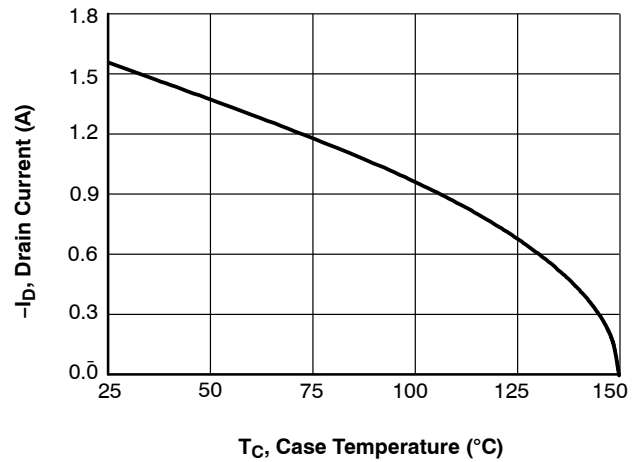


Figure 10. Maximum Drain Current vs. Case Temperature

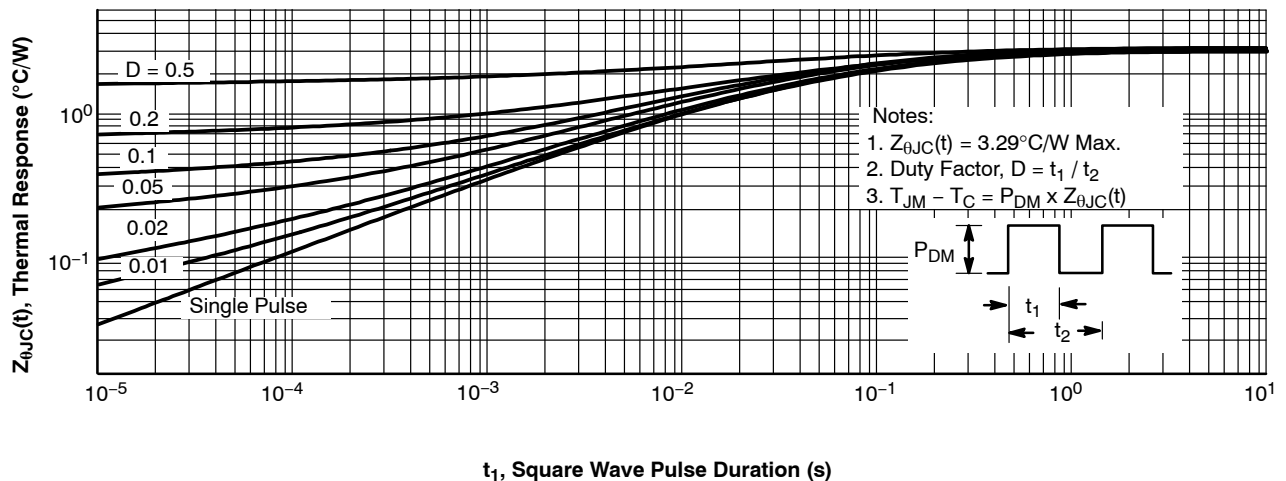


Figure 11. Transient Thermal Response Curve

## FQD2P40

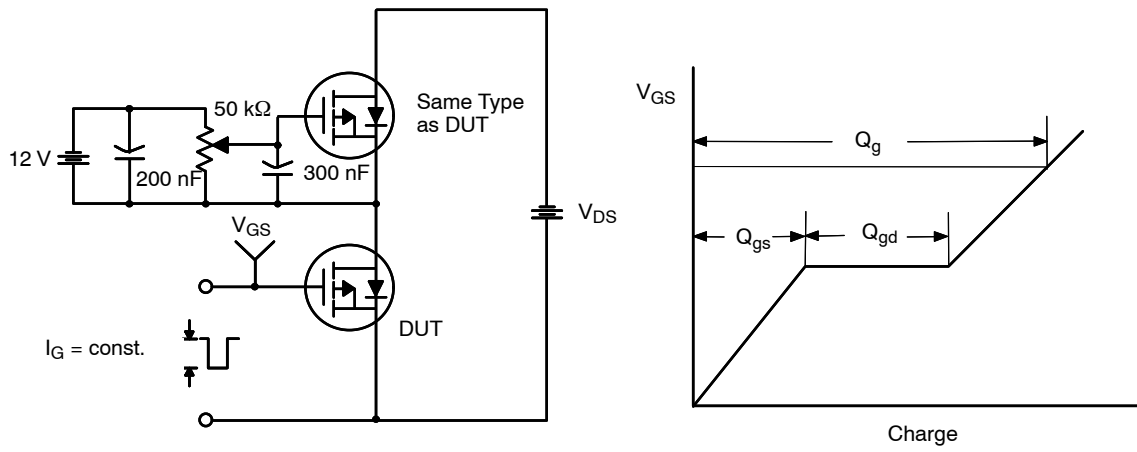


Figure 12. Gate Charge Test Circuit & Waveform

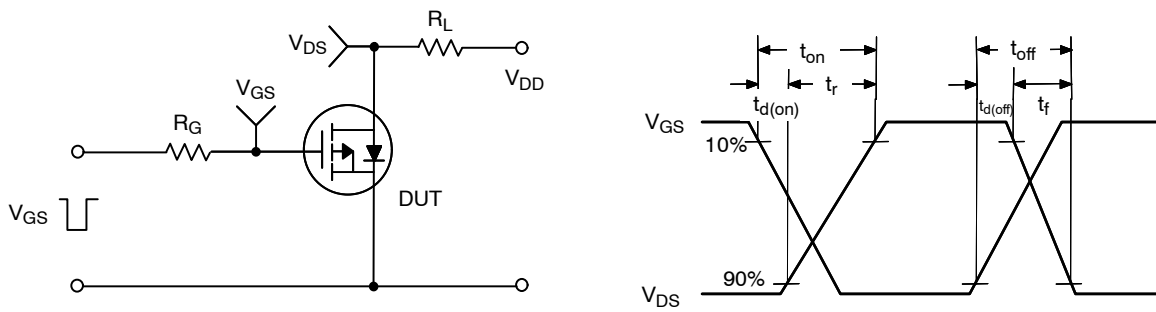


Figure 13. Resistive Switching Test Circuit & Waveforms

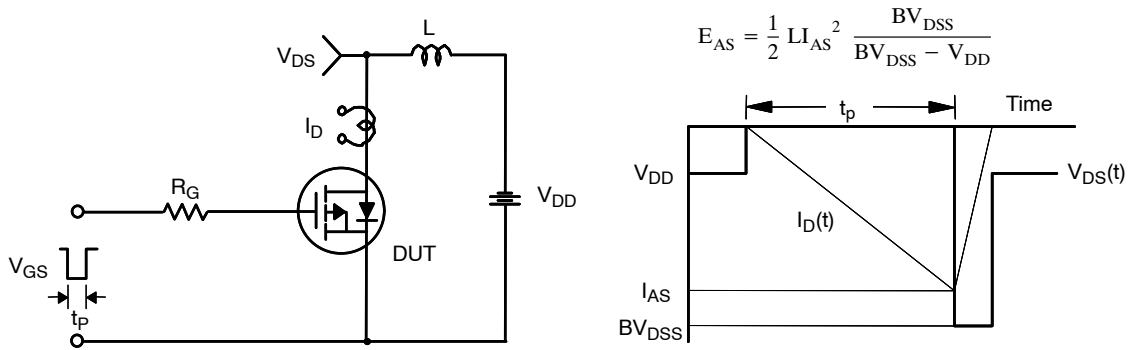
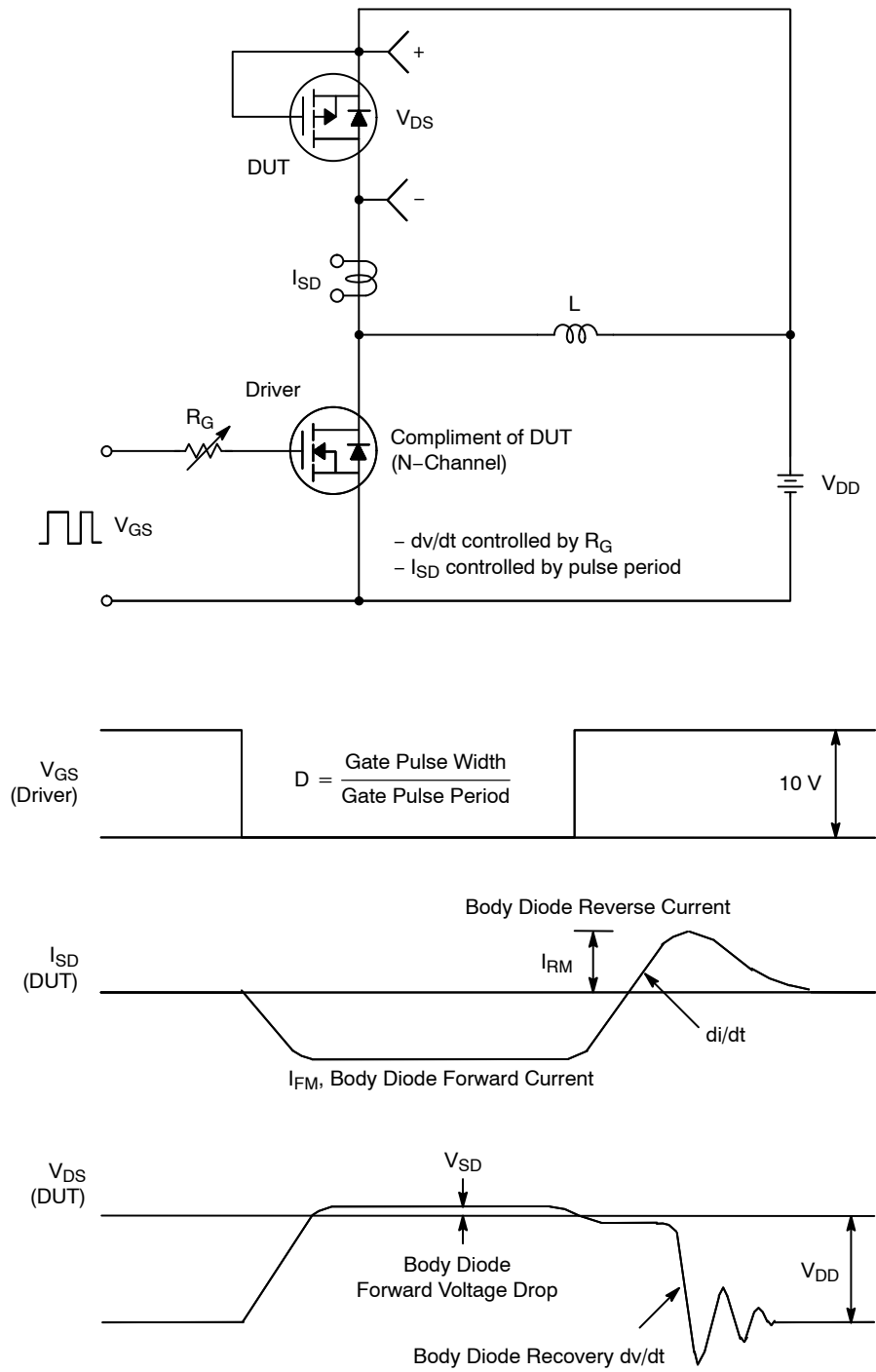
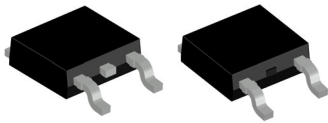


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms

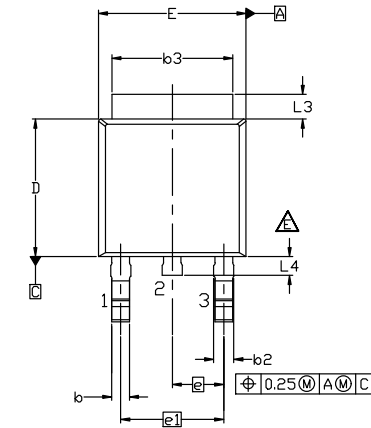
# FQD2P40



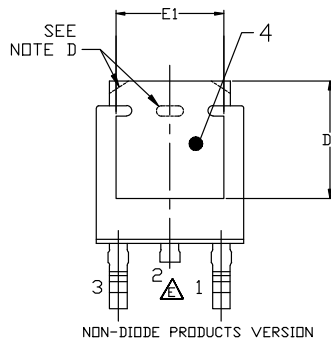
**Figure 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms**


**DPAK3 6.10x6.54x2.29, 4.57P**  
**CASE 369AS**  
**ISSUE B**

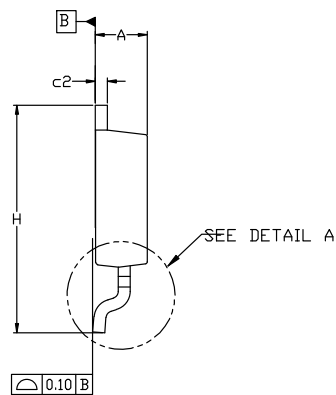
DATE 20 DEC 2023



NON-DIODE PRODUCTS VERSION



NON-DIODE PRODUCTS VERSION



NOTES: UNLESS OTHERWISE SPECIFIED

A) THIS PACKAGE CONFORMS TO JEDEC, TO-252, ISSUE F, VARIATION AA.

B) ALL DIMENSIONS ARE IN MILLIMETERS.

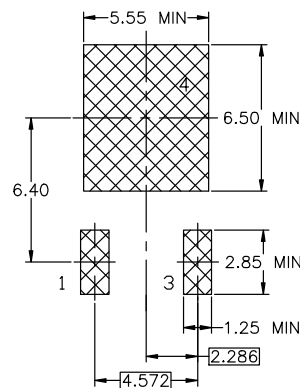
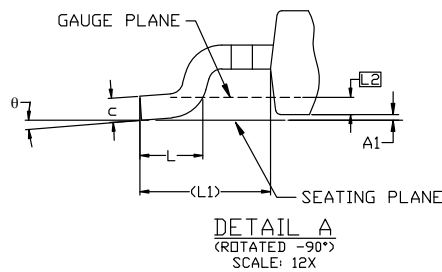
C) DIMENSIONING AND TOLERANCING PER ASME Y14.5M-2018.

D) SUPPLIER DEPENDENT MOLD LOCKING HOLES OR CHAMFERED CORNERS OR EDGE PROTRUSION.

E) FOR DIODE PRODUCTS, L4 IS 0.25 MM MAX PLASTIC BODY STUB WITHOUT CENTER LEAD.

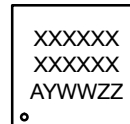
F) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR EXTRUSIONS.

G) LAND PATTERN RECOMMENDATION IS BASED ON IPC7351A STD TD228P991X239-3N.


**LAND PATTERN RECOMMENDATION**

\*FOR ADDITIONAL INFORMATION ON OUR Pb-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERM/D.

| DIM | MILLIMETERS |      |       |
|-----|-------------|------|-------|
|     | MIN.        | NDM. | MAX.  |
| A   | 2.18        | 2.29 | 2.39  |
| A1  | 0.00        | -    | 0.127 |
| b   | 0.64        | 0.77 | 0.89  |
| b2  | 0.76        | 0.95 | 1.14  |
| b3  | 5.21        | 5.34 | 5.46  |
| c   | 0.45        | 0.53 | 0.61  |
| c2  | 0.45        | 0.52 | 0.58  |
| D   | 5.97        | 6.10 | 6.22  |
| D1  | 5.21        | ---  | ---   |
| E   | 6.35        | 6.54 | 6.73  |
| E1  | 4.32        | ---  | ---   |
| e   | 2.286 BSC   |      |       |
| e1  | 4.572 BSC   |      |       |
| H   | 9.40        | 9.91 | 10.41 |
| L   | 1.40        | 1.59 | 1.78  |
| L1  | 2.90 REF    |      |       |
| L2  | 0.51 BSC    |      |       |
| L3  | 0.89        | 1.08 | 1.27  |
| L4  | ---         | ---  | 1.02  |
| θ   | 0°          | ---  | 10°   |

**GENERIC MARKING DIAGRAM\***


\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.

XXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
ZZ = Assembly Lot Code

|                         |                                    |                                                                                                                                                                                  |
|-------------------------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| <b>DESCRIPTION:</b>     | <b>DPAK3 6.10x6.54x2.29, 4.57P</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                               |

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