

# MOSFET – P-Channel, POWERTRENCH®

30 V

**FDD6685**

## General Description

This P-Channel MOSFET is a rugged gate version of onsemi's advanced POWERTRENCH process. It has been optimized for power management applications requiring a wide range of gate drive voltage ratings (4.5 V – 2.5 V).

## Features

- -40 A, -30 V
  - ♦  $R_{DS(ON)} = 20\text{ m}\Omega$  @  $V_{GS} = -10\text{ V}$
  - ♦  $R_{DS(ON)} = 30\text{ m}\Omega$  @  $V_{GS} = -4.5\text{ V}$
- Fast Switching Speed
- High Performance Trench Technology for Extremely Low  $R_{DS(ON)}$
- High Power and Current Handling Capability
- Qualified to AEC-Q101
- This Device is Pb-Free and are RoHS Compliant

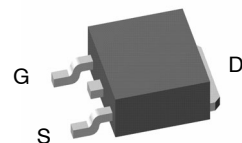
## ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ , Unless otherwise noted)

| Symbol         | Parameter                                        | Ratings                                            | Units            |
|----------------|--------------------------------------------------|----------------------------------------------------|------------------|
| $V_{DSS}$      | Drain-Source Voltage                             | -30                                                | V                |
| $V_{GSS}$      | Gate-Source Voltage                              | $\pm 25$                                           | V                |
| $I_D$          | Continuous Drain Current                         | @ $T_C = 25^\circ\text{C}$ (Note 5)                | A                |
|                |                                                  | @ $T_A = 25^\circ\text{C}$ (Note 3a)               |                  |
|                |                                                  | Pulsed, $PW \leq 100\text{ }\mu\text{s}$ (Note 3b) |                  |
| $P_D$          | Power Dissipation for Single Operation           | (Note 3)                                           | W                |
|                |                                                  | (Note 3a)                                          |                  |
|                |                                                  | (Note 3b)                                          |                  |
|                |                                                  | (Note 3b)                                          |                  |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range | -55 to +175                                        | $^\circ\text{C}$ |

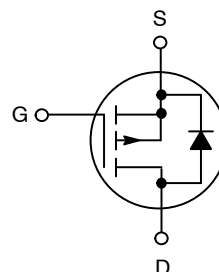
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

## THERMAL CHARACTERISTICS

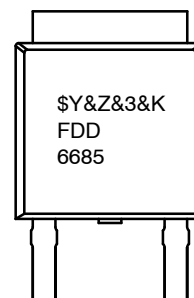
| Symbol          | Parameter                                         | Ratings | Unit               |
|-----------------|---------------------------------------------------|---------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case (Note 3)     | 2.9     | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (Note 3a) | 40      | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (Note 3b) | 96      | $^\circ\text{C/W}$ |



DPAK3 (TO-252 3 LD)  
CASE 369AS



## MARKING DIAGRAM



\$Y = onsemi Logo  
 &Z = Assembly Plant Code  
 &3 = Numeric Date Code  
 &K = Lot Code  
 FDD6685 = Specific Device Code

## ORDERING INFORMATION

See detailed ordering and shipping information on page 6 of this data sheet.

# FDD6685

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

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

### DRAIN-SOURCE AVALANCHE RATINGS (NOTE 4)

|          |                                            |                      |   |     |   |    |
|----------|--------------------------------------------|----------------------|---|-----|---|----|
| $E_{AS}$ | Single Pulse Drain-Source Avalanche Energy | $I_D = -11\text{ A}$ | – | 42  | – | mJ |
| $I_{AS}$ | Maximum Drain-Source Avalanche Current     |                      | – | –11 | – | A  |

### OFF CHARACTERISTICS

|                                |                                           |                                                                    |     |     |           |                      |
|--------------------------------|-------------------------------------------|--------------------------------------------------------------------|-----|-----|-----------|----------------------|
| $BV_{DSS}$                     | Drain-Source Breakdown Voltage            | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$               | –30 | –   | –         | V                    |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = -250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$ | –   | –24 | –         | mV/ $^\circ\text{C}$ |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current           | $V_{DS} = -24\text{ V}, V_{GS} = 0\text{ V}$                       | –   | –   | –1        | $\mu\text{A}$        |
| $I_{GSS}$                      | Gate-Body Leakage                         | $V_{GS} = \pm 25\text{ V}, V_{DS} = 0\text{ V}$                    | –   | –   | $\pm 100$ | nA                   |

### ON CHARACTERISTICS

|                                  |                                                |                                                                                                                                                                    |     |                |          |                      |
|----------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------------|----------|----------------------|
| $V_{GS(th)}$                     | Gate Threshold Voltage                         | $V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$                                                                                                                   | –1  | –1.8           | –3       | V                    |
| $\Delta V_{GS(th)} / \Delta T_J$ | Gate Threshold Voltage Temperature Coefficient | $I_D = -250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$                                                                                                 | –   | 5              | –        | mV/ $^\circ\text{C}$ |
| $R_{DS(on)}$                     | Static Drain-Source On-Resistance              | $V_{GS} = -10\text{ V}, I_D = -11\text{ A}$<br>$V_{GS} = -4.5\text{ V}, I_D = -9\text{ A}$<br>$V_{GS} = -10\text{ V}, I_D = -11\text{ A}, T_J = 125^\circ\text{C}$ | –   | 14<br>21<br>20 | 20<br>30 | m $\Omega$           |
| $I_{D(on)}$                      | On-State Drain Current                         | $V_{GS} = -10\text{ V}, V_{DS} = -5\text{ V}$                                                                                                                      | –20 | –              | –        | A                    |
| $g_{FS}$                         | Forward Transconductance                       | $V_{DS} = -5\text{ V}, I_D = -11\text{ A}$                                                                                                                         | –   | 26             | –        | S                    |

### DYNAMIC CHARACTERISTICS

|           |                              |                                                                  |   |      |   |          |
|-----------|------------------------------|------------------------------------------------------------------|---|------|---|----------|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = -15\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$ | – | 1715 | – | pF       |
| $C_{oss}$ | Output Capacitance           |                                                                  | – | 440  | – | pF       |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                  | – | 225  | – | pF       |
| $R_G$     | Gate Resistance              | $V_{GS} = 15\text{ mV}, f = 1.0\text{ MHz}$                      | – | 3.6  | – | $\Omega$ |

### SWITCHING CHARACTERISTICS

|              |                     |                                                                                              |   |    |    |    |
|--------------|---------------------|----------------------------------------------------------------------------------------------|---|----|----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = -15\text{ V}, I_D = -1\text{ A}, V_{GS} = -10\text{ V}, R_{GEN} = 6\text{ }\Omega$ | – | 17 | 31 | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                              | – | 11 | 21 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                              | – | 43 | 68 | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                              | – | 21 | 34 | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = -15\text{ V}, I_D = -11\text{ A}, V_{GS} = -5\text{ V}$                            | – | 17 | 24 | nC |
| $Q_{gs}$     | Gate-Source Charge  |                                                                                              | – | 9  | –  | nC |
| $Q_{gd}$     | Gate-Drain Charge   |                                                                                              | – | 4  | –  | nC |

### DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

|          |                                    |                                                          |   |      |      |    |
|----------|------------------------------------|----------------------------------------------------------|---|------|------|----|
| $V_{SD}$ | Drain-Source Diode Forward Voltage | $V_{GS} = 0\text{ V}, I_S = -3.2\text{ A}$ (Note 4)      | – | –0.8 | –1.2 | V  |
| $T_{rr}$ | Diode Reverse Recovery Time        | $I_F = -11\text{ A}, dI_F/dt = 100\text{ A}/\mu\text{s}$ | – | 26   | –    | ns |
| $Q_{rr}$ | Diode Reverse Recovery Charge      |                                                          | – | 13   | –    | nC |

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.

## FDD6685

### NOTES:

1. This product has been designed to meet the extreme test conditions and environment demanded by the automotive industry.
2. All **onsemi** products are manufactured, assembled and tested under ISO9000 and QS9000 quality systems certification.
3.  $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



- a)  $R_{\theta JA} = 40^{\circ}\text{C/W}$  when mounted on  
■  $1\text{in}^2$  pad of 2 oz copper



- b)  $R_{\theta JA} = 96^{\circ}\text{C/W}$  when mounted on  
■ a minimum pad

4. Pulse Test: Pulse Width  $< 300\ \mu\text{s}$ , Duty Cycle  $< 2.0\%$
5. Maximum current is calculated as:

$$\sqrt{\frac{P_D}{R_{DS(ON)}}}$$

where  $P_D$  is maximum power dissipation at  $T_C = 25^{\circ}\text{C}$  and  $R_{DS(on)}$  is at  $T_{J(max)}$  and  $V_{GS} = 10\ \text{V}$ .

6. Starting  $T_J = 25^{\circ}\text{C}$ ,  $L = 0.69\ \text{mH}$ ,  $I_{AS} = -11\ \text{A}$

## TYPICAL CHARACTERISTICS

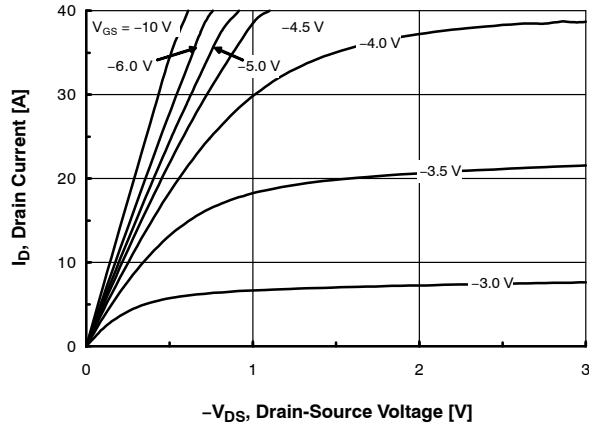


Figure 1. On-Region Characteristics

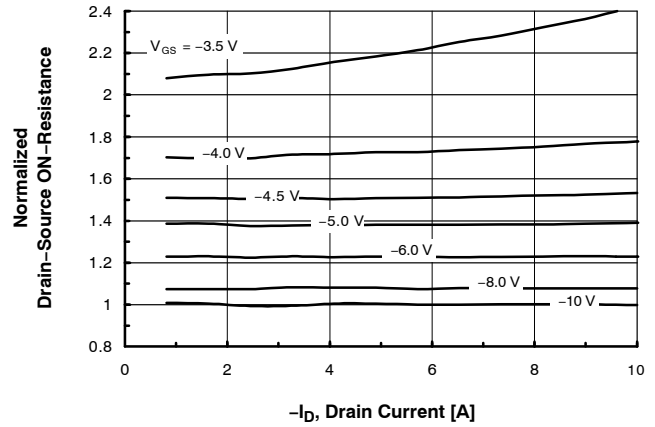


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage

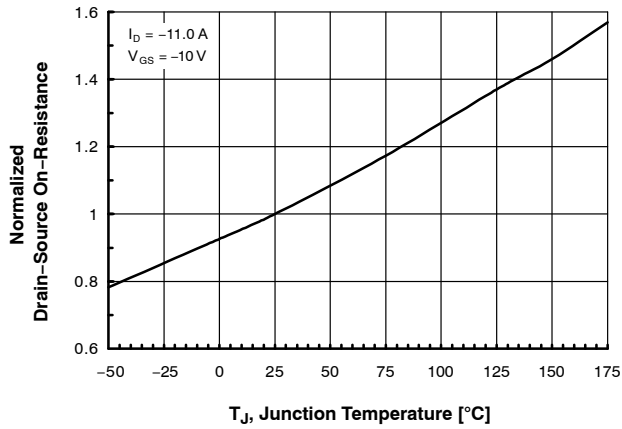


Figure 3. On-Resistance Variation with Temperature

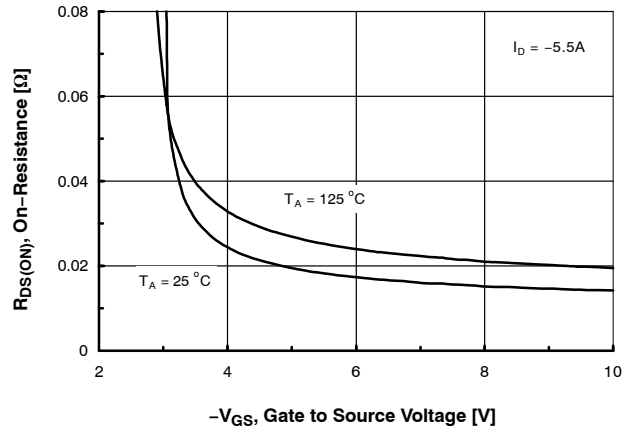


Figure 4. On-Resistance Variation with Gate-to-Source Voltage

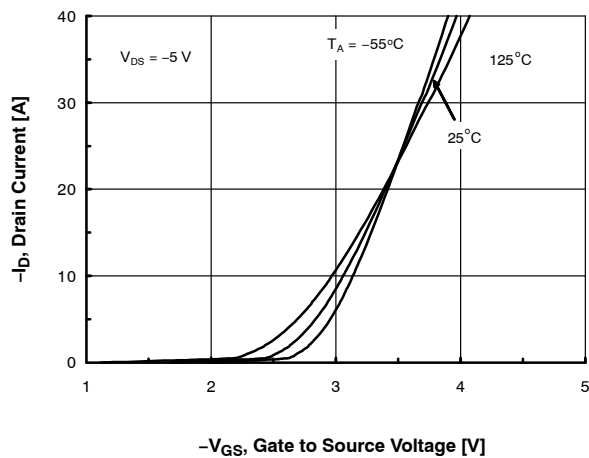


Figure 5. Transfer Characteristics

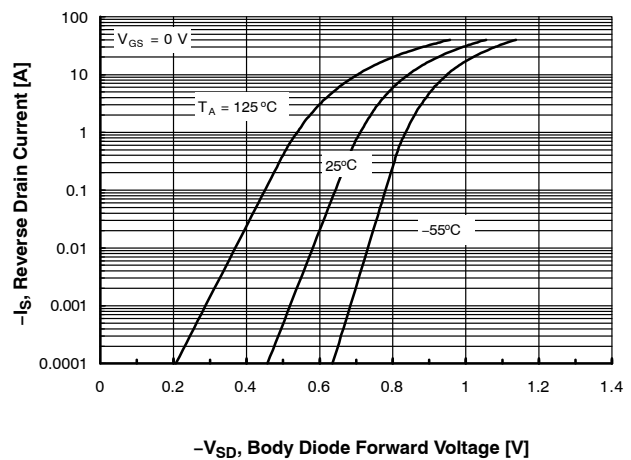


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

## TYPICAL CHARACTERISTICS (continued)

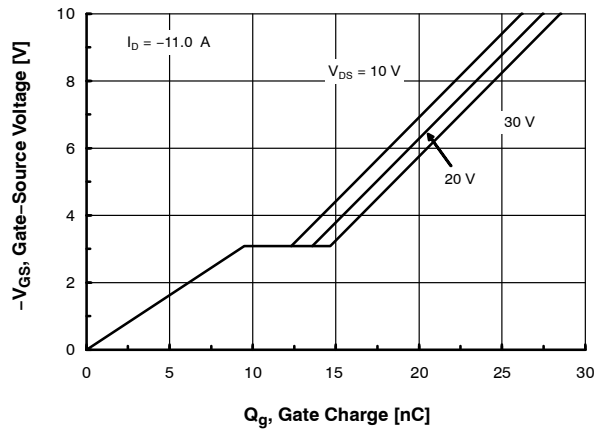


Figure 7. Gate Charge Characteristics

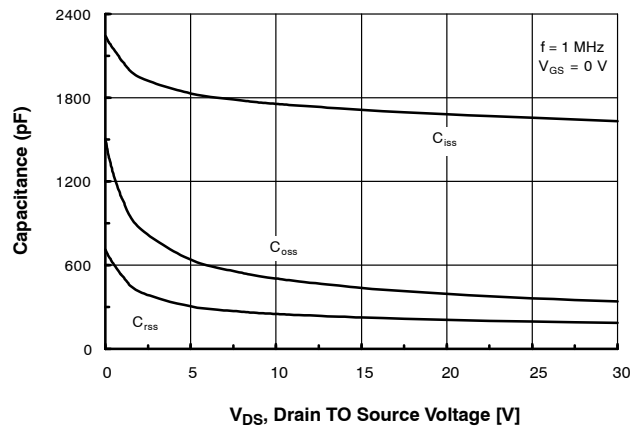


Figure 8. Capacitance Characteristics

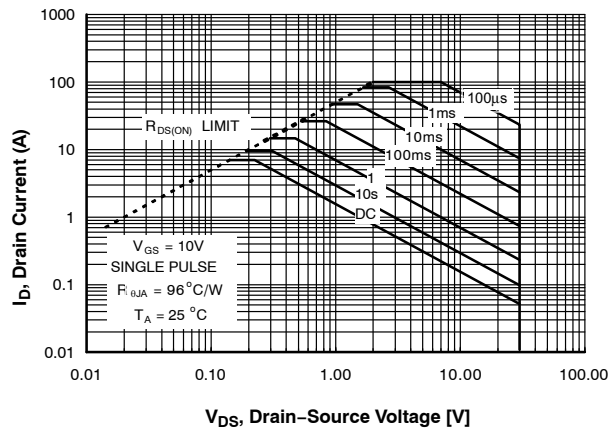


Figure 9. Maximum Safe Operating Area

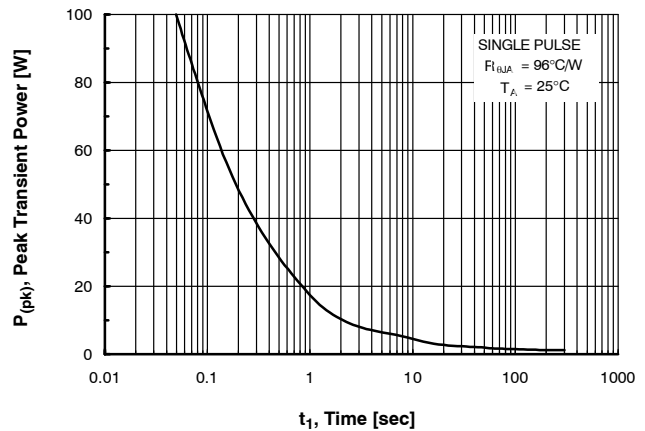


Figure 10. Single Pulse Minimum Power Dissipation

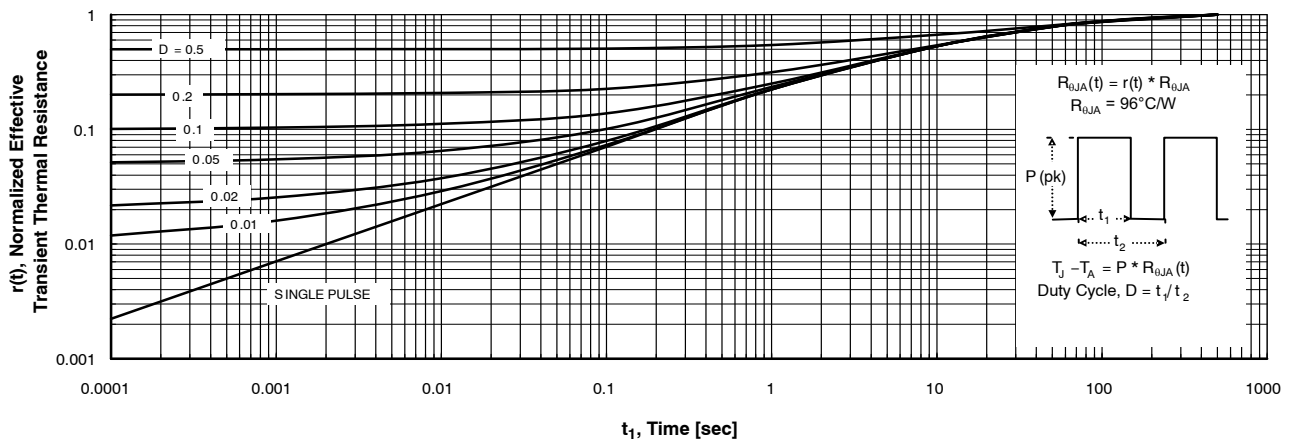


Figure 11. Transient Thermal Response Curve

## NOTES:

7. Thermal characterization performed using the conditions described in Note 3b.
8. Transient thermal response will change depending on the circuit board design.

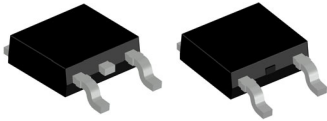
## FDD6685

### PACKAGE MARKING AND ORDERING INFORMATION

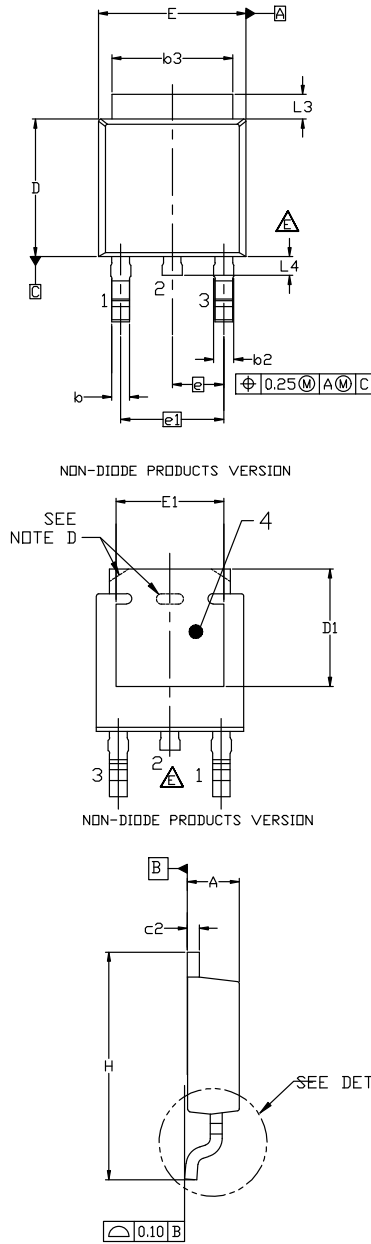
| Part Number | Device  | Reel Size | Tape Width | Shipping <sup>†</sup> |
|-------------|---------|-----------|------------|-----------------------|
| FDD6685     | FDD6685 | 13"       | 16 mm      | 2,500 Tape & Reels    |

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

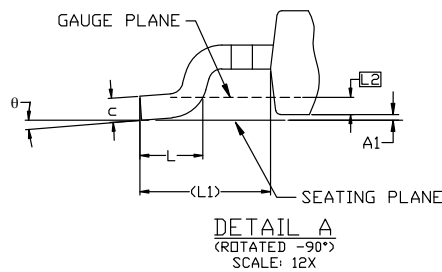
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**DPAK3 6.10x6.54x2.29, 4.57P**  
**CASE 369AS**  
**ISSUE B**

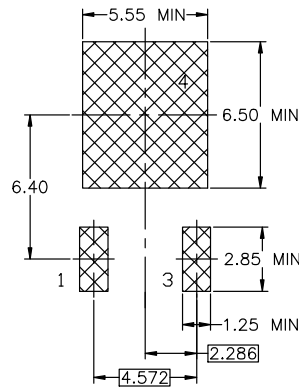
DATE 20 DEC 2023



- 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 TQ228P991X239-3N.



| 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°   |


**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.

**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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