

# MOSFET – Dual, N-Channel, Asymmetric, Power Clip, POWER trench<sup>®</sup>, 30 V

## FDPC8013S

### General Description

This device includes two specialized N-Channel MOSFETs in a dual package. The switch node has been internally connected to enable easy placement and routing of synchronous buck converters. The control MOSFET (Q1) and synchronous SyncFET™ (Q2) have been designed to provide optimal power efficiency.

### Features

Q1: N-Channel

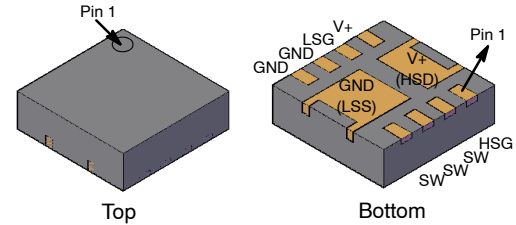
- Max  $R_{DS(on)}$  = 9.6 mΩ at  $V_{GS}$  = 4.5 V,  $I_D$  = 10 A

Q2: N-Channel

- Max  $R_{DS(on)}$  = 2.7 mΩ at  $V_{GS}$  = 4.5 V,  $I_D$  = 22 A
- Low Inductance Packaging Shortens Rise/Fall Times, Resulting in Lower Switching Losses
- MOSFET Integration Enables Optimum Layout for Lower Circuit Inductance and Reduced Switch Node Ringing
- RoHS Compliant

### Applications

- Computing
- Communications
- General Purpose Point of Load



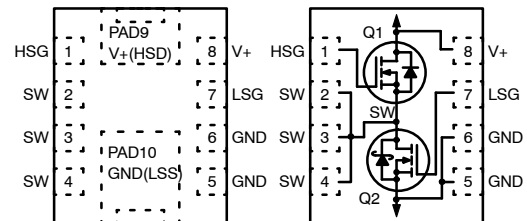
PQFN8 3.3 × 3.3, 0.65P  
CASE 483AZ

### MARKING DIAGRAM

&Z&3&K  
13CF  
15CF

&Z = Assembly Plant Code  
&3 = 3-Digit Date Code  
&K = 2-Digits Lot Run Traceability Code  
13CF15CF = Device Code

### PIN ASSIGNMENT



### ORDERING INFORMATION

| Device    | Package | Shipping†          |
|-----------|---------|--------------------|
| FDPC8013S | PQFN8   | 3000 / 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](http://www.onsemi.com/BRD8011/D).

# FDPC8013S

## MOSFET MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise noted)

| Symbol                            | Parameter                                        |                                                      | Q1            | Q2            | Unit |
|-----------------------------------|--------------------------------------------------|------------------------------------------------------|---------------|---------------|------|
| V <sub>DS</sub>                   | Drain to Source Voltage                          |                                                      | 30            | 30            | V    |
| V <sub>GS</sub>                   | Gate to Source Voltage                           |                                                      | ±20           | ±20           | V    |
| I <sub>D</sub>                    | Drain Current                                    | – Continuous (Package limited) T <sub>C</sub> = 25°C | 20            | 55            | A    |
|                                   |                                                  | – Continuous T <sub>A</sub> = 25°C                   | 13 (Note 1a)  | 26 (Note 1b)  |      |
|                                   |                                                  | – Pulsed                                             | 40            | 100           |      |
| E <sub>AS</sub>                   | Single Pulse Avalanche Energy (Note 3)           |                                                      | 21            | 97            | mJ   |
| P <sub>D</sub>                    | Power Dissipation for Single Operation           | T <sub>A</sub> = 25°C                                | 1.6 (Note 1a) | 2.0 (Note 1b) | W    |
|                                   |                                                  | T <sub>A</sub> = 25°C                                | 0.8 (Note 1c) | 0.9 (Note 1d) |      |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage Junction Temperature Range |                                                      | –55 to +150   |               | °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           | Characteristic                          | Value         | Value         | Unit |
|------------------|-----------------------------------------|---------------|---------------|------|
| R <sub>θJA</sub> | Thermal Resistance, Junction to Ambient | 77 (Note 1a)  | 63 (Note 1b)  | °C/W |
| R <sub>θJA</sub> | Thermal Resistance, Junction to Ambient | 151 (Note 1c) | 135 (Note 1d) |      |
| R <sub>θJC</sub> | Thermal Resistance, Junction to Case    | 5.0           | 3.5           |      |

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

| Symbol                               | Parameter                                 | Test Condition                                                                                 | Type     | Min      | Typ      | Max        | Unit     |
|--------------------------------------|-------------------------------------------|------------------------------------------------------------------------------------------------|----------|----------|----------|------------|----------|
| <b>OFF CHARACTERISTICS</b>           |                                           |                                                                                                |          |          |          |            |          |
| BV <sub>DSS</sub>                    | Drain to Source Breakdown Voltage         | I <sub>D</sub> = 250 μA, V <sub>GS</sub> = 0 V<br>I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0 V | Q1<br>Q2 | 30<br>30 | –<br>–   | –<br>–     | V        |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 250 μA, referenced to 25°C<br>I <sub>D</sub> = 10 mA, referenced to 25°C      | Q1<br>Q2 | –<br>–   | 16<br>20 | –<br>–     | mV/°C    |
| I <sub>DSS</sub>                     | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = 24 V, V <sub>GS</sub> = 0 V<br>V <sub>DS</sub> = 24 V, V <sub>GS</sub> = 0 V | Q1<br>Q2 | –<br>–   | –<br>–   | 1<br>500   | μA<br>μA |
| I <sub>GSS</sub>                     | Gate to Source Leakage Current, Forward   | V <sub>GS</sub> = 20 V, V <sub>DS</sub> = 0 V<br>V <sub>GS</sub> = 20 V, V <sub>DS</sub> = 0 V | Q1<br>Q2 | –<br>–   | –<br>–   | 100<br>100 | nA<br>nA |

## ON CHARACTERISTICS

|                                        |                                                          |                                                                                                                                                                          |          |             |                   |                   |       |
|----------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|-------------------|-------------------|-------|
| V <sub>GS(th)</sub>                    | Gate to Source Threshold Voltage                         | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250 μA<br>V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1 mA                                                 | Q1<br>Q2 | 1.2<br>1.2  | 1.5<br>1.7        | 3.0<br>3.0        | V     |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate to Source Threshold Voltage Temperature Coefficient | I <sub>D</sub> = 250 μA, referenced to 25°C<br>I <sub>D</sub> = 10 mA, referenced to 25°C                                                                                | Q1<br>Q2 | –<br>–      | –5<br>–6          | –<br>–            | mV/°C |
| R <sub>DS(on)</sub>                    | Drain to Source On Resistance                            | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 13 A<br>V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 10 A<br>V <sub>GS</sub> = 10 V, I <sub>D</sub> = 13 A, T <sub>J</sub> = 125°C | Q1       | –<br>–<br>– | 4.6<br>6.7<br>6.6 | 6.4<br>9.6<br>9.2 | mΩ    |
|                                        |                                                          | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 26 A<br>V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 22 A<br>V <sub>GS</sub> = 10 V, I <sub>D</sub> = 26 A, T <sub>J</sub> = 125°C | Q2       | –<br>–<br>– | 1.4<br>2.0<br>1.9 | 1.9<br>2.7<br>2.6 |       |
| g <sub>FS</sub>                        | Forward Transconductance                                 | V <sub>DS</sub> = 5 V, I <sub>D</sub> = 13 A                                                                                                                             | Q1       | –           | 53                | –                 | S     |
|                                        |                                                          | V <sub>DS</sub> = 5 V, I <sub>D</sub> = 26 A                                                                                                                             | Q2       | –           | 168               | –                 |       |

## DYNAMIC CHARACTERISTICS

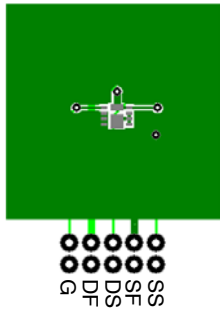
|                  |                              |                                                                                                                                    |          |        |             |        |    |
|------------------|------------------------------|------------------------------------------------------------------------------------------------------------------------------------|----------|--------|-------------|--------|----|
| C <sub>iss</sub> | Input Capacitance            | Q1:<br>V <sub>DS</sub> = 15 V, V <sub>GS</sub> = 0 V, f = 1 MHz<br>Q2:<br>V <sub>DS</sub> = 15 V, V <sub>GS</sub> = 0 V, f = 1 MHz | Q1<br>Q2 | –<br>– | 827<br>2785 | –<br>– | pF |
| C <sub>oss</sub> | Output Capacitance           |                                                                                                                                    | Q1<br>Q2 | –<br>– | 333<br>997  | –<br>– | pF |
| C <sub>rss</sub> | Reverse Transfer Capacitance |                                                                                                                                    | Q1<br>Q2 | –<br>– | 44<br>128   | –<br>– | pF |
| R <sub>g</sub>   | Gate Resistance              |                                                                                                                                    | Q1       | –      | 0.5         | –      | Ω  |
|                  |                              |                                                                                                                                    | Q2       | –      | 0.5         | –      |    |

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

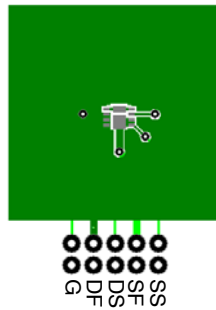
| Symbol                             | Parameter                             | Test Condition                                                                                                                                                   |                                                                                                                      | Type | Min | Typ  | Max | Unit |
|------------------------------------|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|------|-----|------|-----|------|
| SWITCHING CHARACTERISTICS          |                                       |                                                                                                                                                                  |                                                                                                                      |      |     |      |     |      |
| t <sub>d(on)</sub>                 | Turn-On Delay Time                    | Q1:<br>V <sub>DD</sub> = 15 V, I <sub>D</sub> = 13 A, R <sub>GEN</sub> = 6 Ω<br><br>Q2:<br>V <sub>DD</sub> = 15 V, I <sub>D</sub> = 26 A, R <sub>GEN</sub> = 6 Ω |                                                                                                                      | Q1   | –   | 6    | –   | ns   |
| t <sub>r</sub>                     | Rise Time                             |                                                                                                                                                                  |                                                                                                                      | Q2   | –   | 11   | –   | ns   |
| t <sub>d(off)</sub>                | Turn-Off Delay Time                   |                                                                                                                                                                  |                                                                                                                      | Q1   | –   | 2    | –   | ns   |
| t <sub>f</sub>                     | Fall Time                             |                                                                                                                                                                  |                                                                                                                      | Q2   | –   | 30   | –   | ns   |
| Q <sub>g</sub>                     | Total Gate Charge                     | V <sub>GS</sub> = 0 V to 10 V                                                                                                                                    | Q1<br>V <sub>DD</sub> = 15 V,<br>I <sub>D</sub> = 13 A<br><br>Q2<br>V <sub>DD</sub> = 15 V,<br>I <sub>D</sub> = 26 A | Q1   | –   | 13   | –   | nC   |
|                                    |                                       | V <sub>GS</sub> = 0 V to 4.5 V                                                                                                                                   |                                                                                                                      | Q2   | –   | 44   | –   | nC   |
| Q <sub>gs</sub>                    | Gate to Source Gate Charge            |                                                                                                                                                                  |                                                                                                                      | Q1   | –   | 6    | –   | nC   |
| Q <sub>gd</sub>                    | Gate to Drain “Miller” Charge         |                                                                                                                                                                  |                                                                                                                      | Q2   | –   | 21   | –   | nC   |
| Q <sub>gs</sub>                    | Gate to Source Gate Charge            |                                                                                                                                                                  |                                                                                                                      | Q1   | –   | 2.2  | –   | nC   |
| Q <sub>gd</sub>                    | Gate to Drain “Miller” Charge         |                                                                                                                                                                  |                                                                                                                      | Q2   | –   | 7.2  | –   | nC   |
| Q <sub>gs</sub>                    | Gate to Source Gate Charge            |                                                                                                                                                                  |                                                                                                                      | Q1   | –   | 1.9  | –   | nC   |
| Q <sub>gd</sub>                    | Gate to Drain “Miller” Charge         |                                                                                                                                                                  |                                                                                                                      | Q2   | –   | 6.6  | –   | nC   |
| DRAIN-SOURCE DIODE CHARACTERISTICS |                                       |                                                                                                                                                                  |                                                                                                                      |      |     |      |     |      |
| V <sub>SD</sub>                    | Source to Drain Diode Forward Voltage | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 13 A (Note 2)<br>V <sub>GS</sub> = 0 V, I <sub>S</sub> = 26 A (Note 2)                                                   |                                                                                                                      | Q1   | –   | 0.80 | 1.2 | V    |
| t <sub>rr</sub>                    | Reverse Recovery Time                 | Q1:<br>I <sub>F</sub> = 13 A, di/dt = 100 A/μs<br><br>Q2:<br>I <sub>F</sub> = 26 A, di/dt = 300 A/μs                                                             |                                                                                                                      | Q1   | –   | 0.77 | 1.2 | ns   |
| Q <sub>rr</sub>                    | Reverse Recovery Charge               |                                                                                                                                                                  |                                                                                                                      | Q2   | –   | 22   | –   | ns   |
| Q <sub>rr</sub>                    | Reverse Recovery Charge               |                                                                                                                                                                  |                                                                                                                      | Q1   | –   | 7    | –   | nC   |
| Q <sub>rr</sub>                    | Reverse Recovery Charge               |                                                                                                                                                                  |                                                                                                                      | Q2   | –   | 29   | –   | nC   |
| Q <sub>rr</sub>                    | Reverse Recovery Charge               |                                                                                                                                                                  |                                                                                                                      | Q1   | –   | 30   | –   | nC   |
| Q <sub>rr</sub>                    | Reverse Recovery Charge               |                                                                                                                                                                  |                                                                                                                      | Q2   | –   | 7    | –   | 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.

- $R_{\theta JA}$  is determined with the device mounted on a 1 in<sup>2</sup> pad 2 oz copper pad on a 1.5 × 1.5 in. board of FR-4 material.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a.  $77^\circ\text{C}/\text{W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



b.  $63^\circ\text{C}/\text{W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



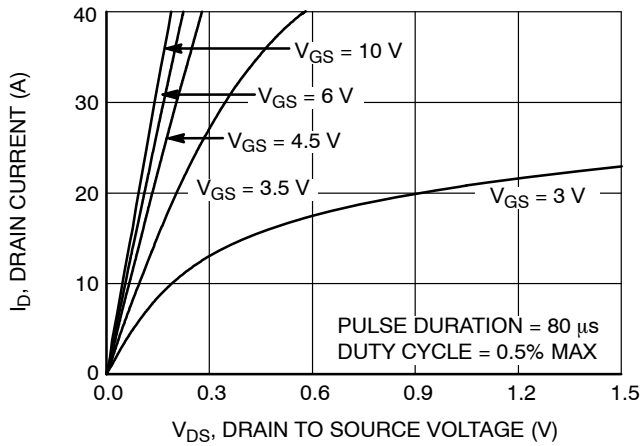
c.  $151^\circ\text{C}/\text{W}$  when mounted on a minimum pad of 2 oz copper



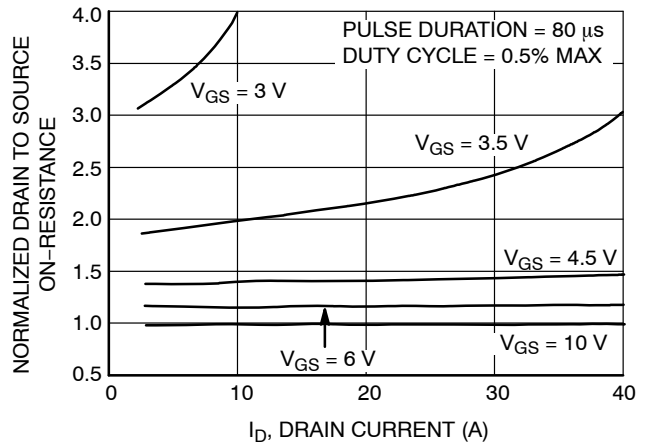
d.  $135^\circ\text{C}/\text{W}$  when mounted on a minimum pad of 2 oz copper

- Pulse Test: Pulse Width < 300  $\mu\text{s}$ , Duty cycle < 2.0%.
- Q1:  $E_{AS}$  of 21 mJ is based on starting  $T_J = 25^\circ\text{C}$ ; N-ch:  $L = 1.2\text{ mH}$ ,  $I_{AS} = 6\text{ A}$ ,  $V_{DD} = 23\text{ V}$ ,  $V_{GS} = 10\text{ V}$ . 100% test at  $L = 0.1\text{ mH}$ ,  $I_{AS} = 14.5\text{ A}$ .  
Q2:  $E_{AS}$  of 97 mJ is based on starting  $T_J = 25^\circ\text{C}$ ; N-ch:  $L = 0.6\text{ mH}$ ,  $I_{AS} = 18\text{ A}$ ,  $V_{DD} = 23\text{ V}$ ,  $V_{GS} = 10\text{ V}$ . 100% test at  $L = 0.1\text{ mH}$ ,  $I_{AS} = 32.9\text{ A}$ .
- As an N-ch device, the negative  $V_{GS}$  rating is for low duty cycle pulse occurrence only. No continuous rating is implied.

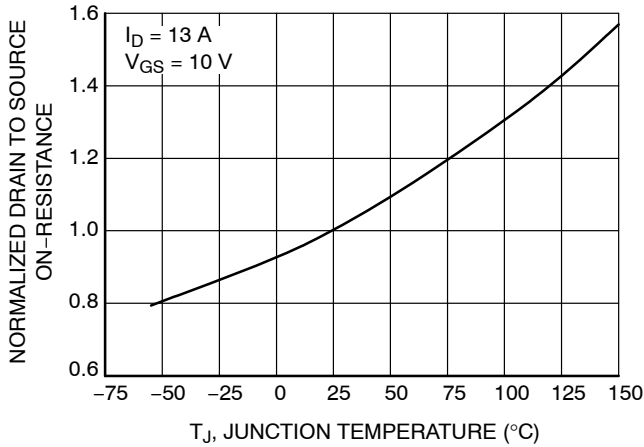
**TYPICAL CHARACTERISTICS (Q1 N-CHANNEL)** ( $T_J = 25^\circ\text{C}$  unless otherwise noted)



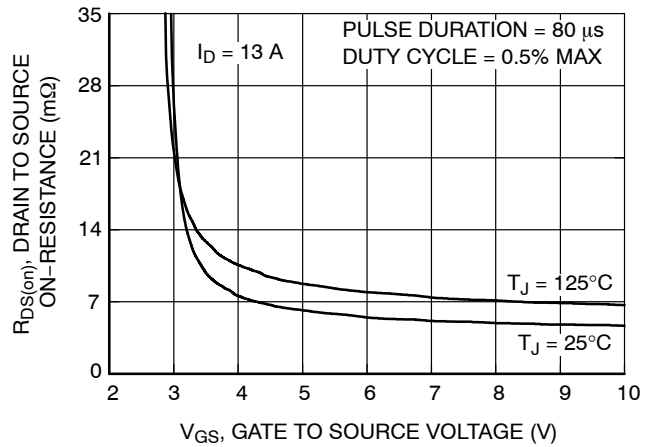
**Figure 1. On-Region Characteristics**



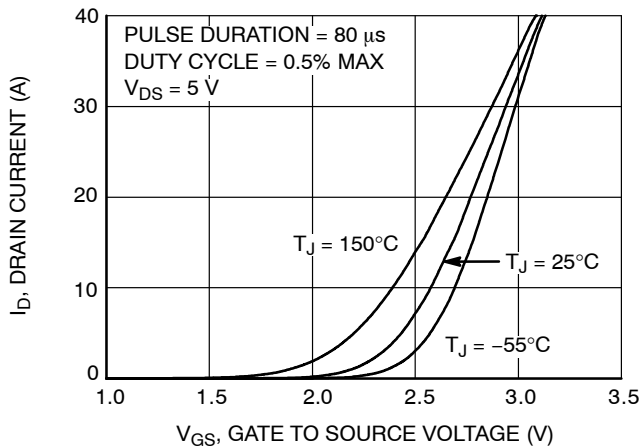
**Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage**



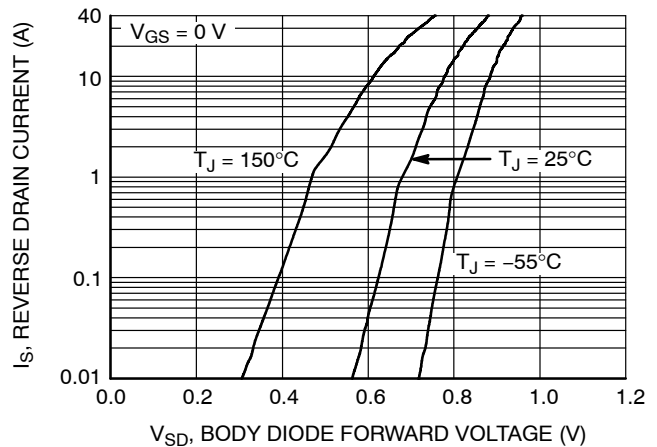
**Figure 3. Normalized On-Resistance vs. Junction Temperature**



**Figure 4. On-Resistance vs. Gate to Source Voltage**



**Figure 5. Transfer Characteristics**



**Figure 6. Source to Drain Diode Forward Voltage vs. Source Current**

TYPICAL CHARACTERISTICS (Q1 N-CHANNEL) ( $T_J = 25^\circ\text{C}$  unless otherwise noted) (continued)

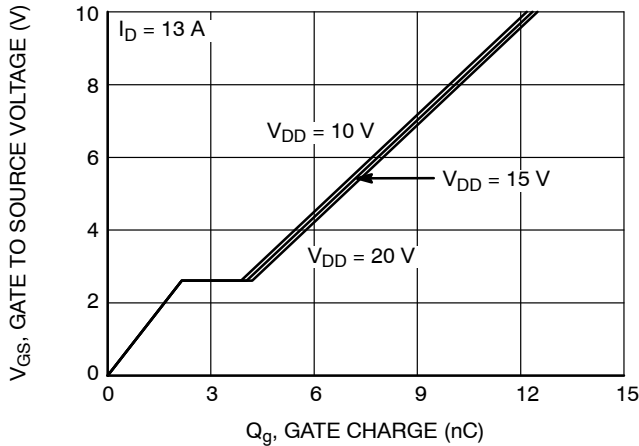


Figure 7. Gate Charge Characteristics

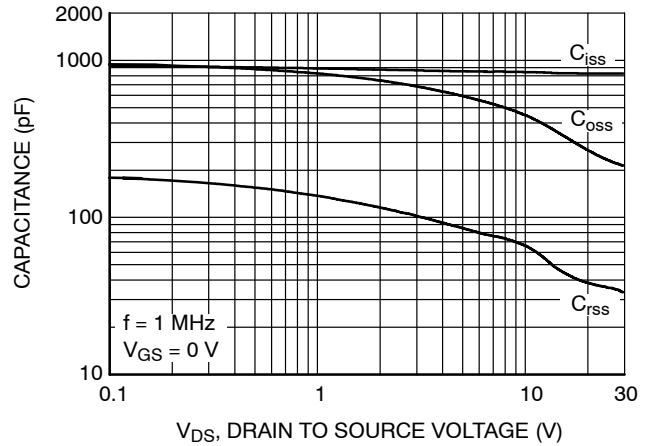


Figure 8. Capacitance vs. Drain to Source Voltage

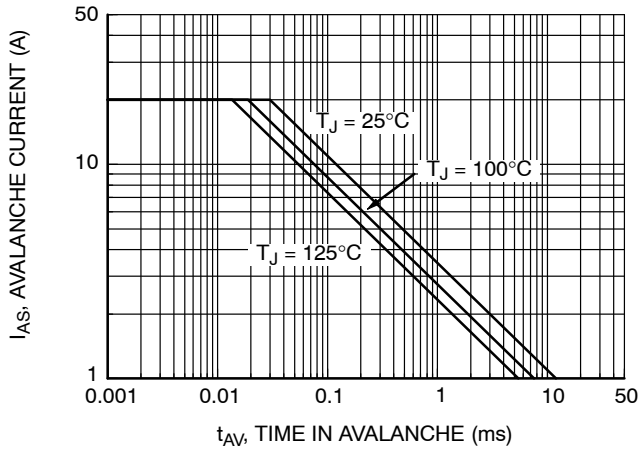


Figure 9. Unclamped Inductive Switching Capability

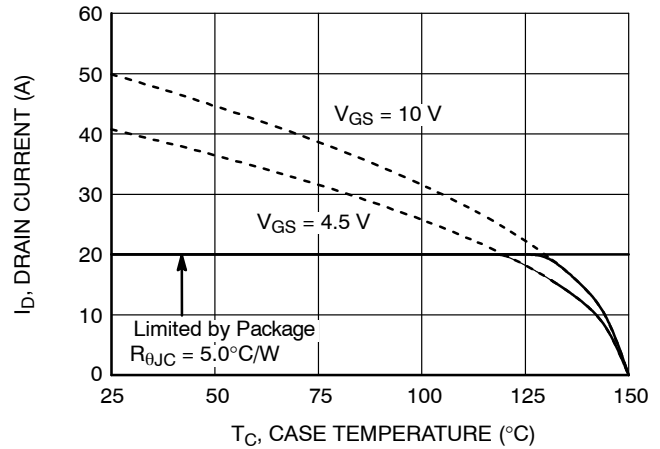


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

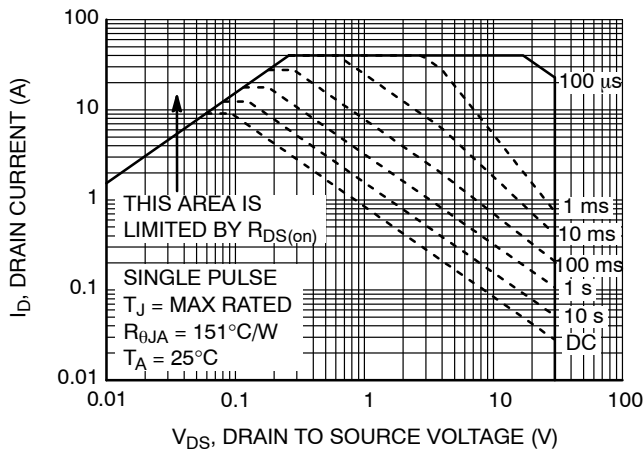


Figure 11. Forward Bias Safe Operating Area

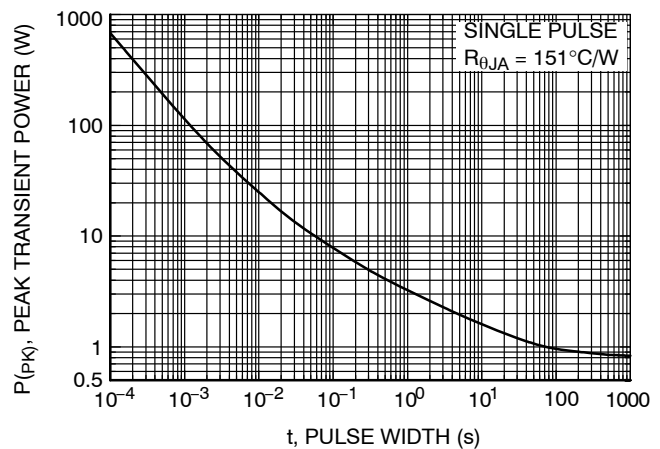


Figure 12. Single Pulse Maximum Power Dissipation

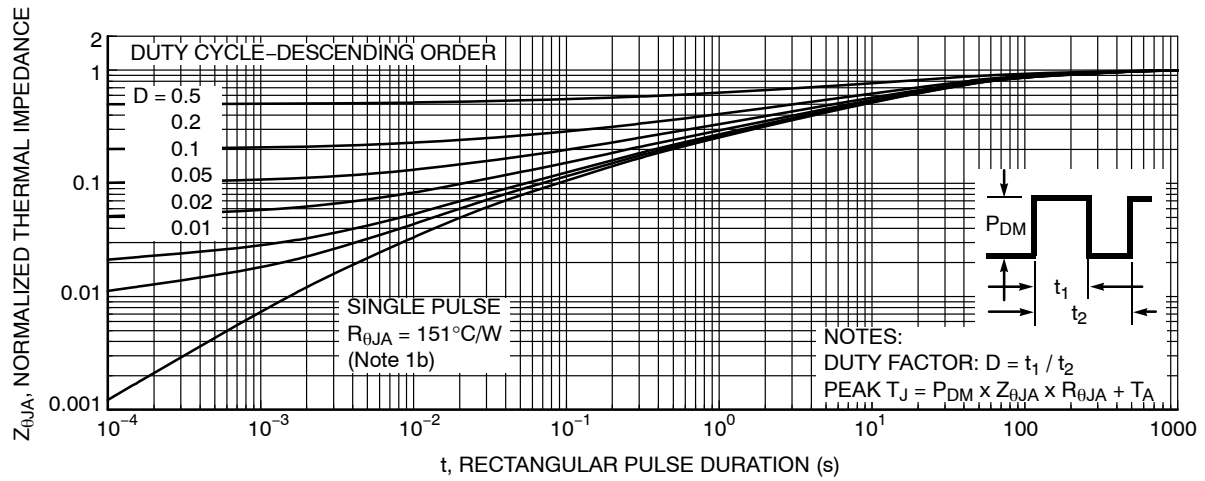
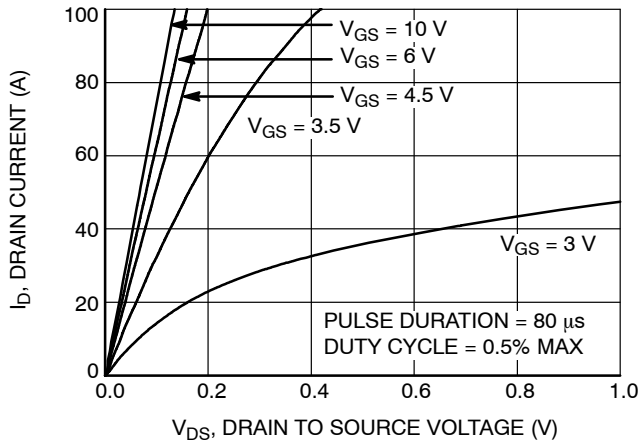
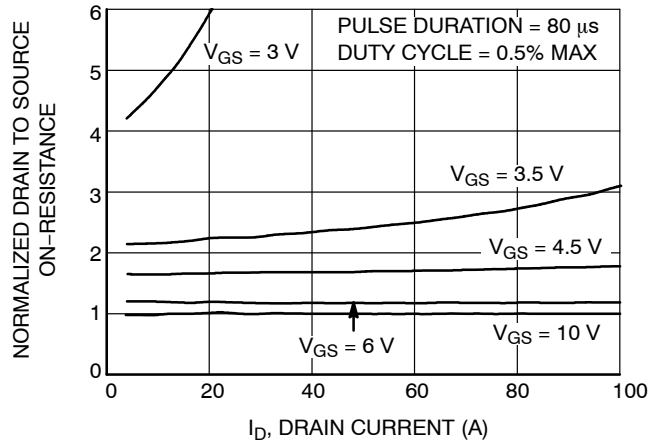
TYPICAL CHARACTERISTICS (Q1 N-CHANNEL) ( $T_J = 25^\circ\text{C}$  unless otherwise noted) (continued)

Figure 13. Junction-to-Ambient Transient Thermal Response Curve

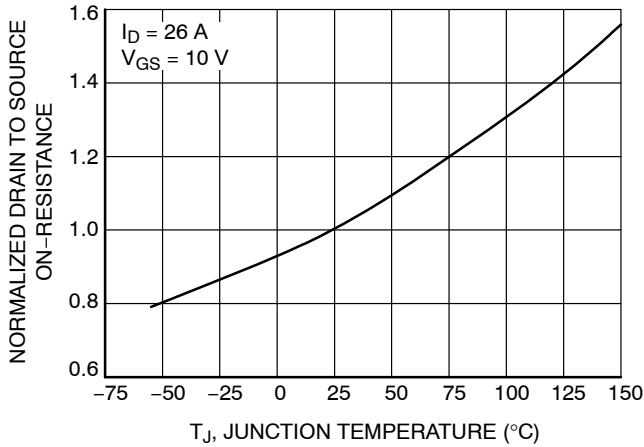
**TYPICAL CHARACTERISTICS (Q2 N-CHANNEL)** ( $T_J = 25^\circ\text{C}$  unless otherwise noted)



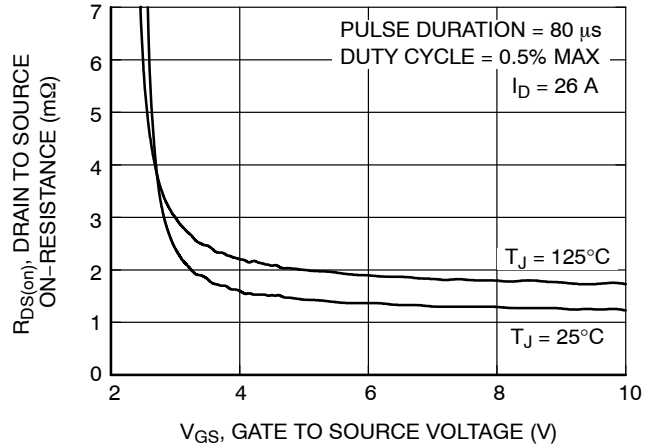
**Figure 14. On-Region Characteristics**



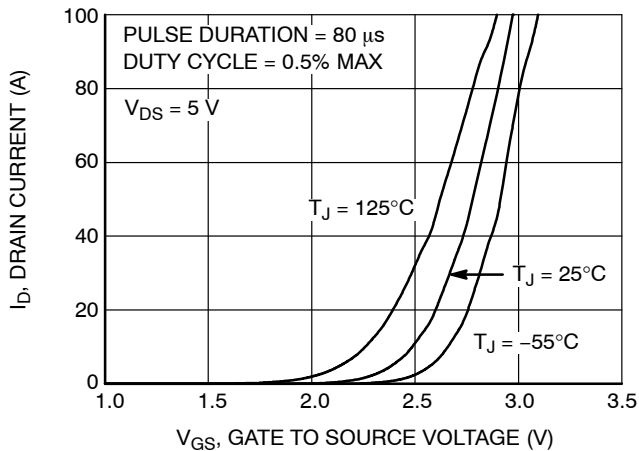
**Figure 15. Normalized On-Resistance vs. Drain Current and Gate Voltage**



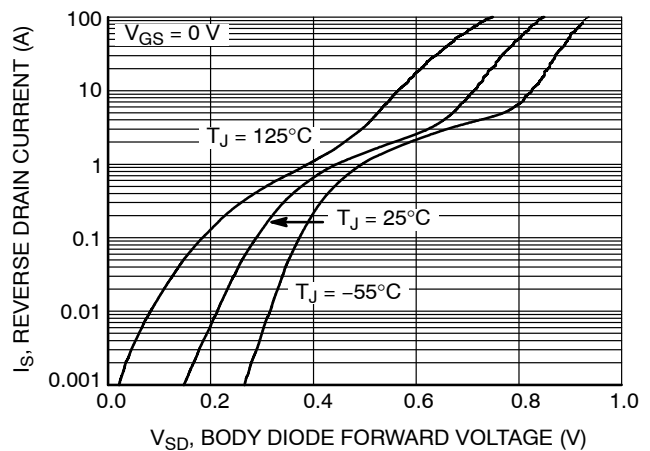
**Figure 16. Normalized On-Resistance vs. Junction Temperature**



**Figure 17. On-Resistance vs. Gate to Source Voltage**



**Figure 18. Transfer Characteristics**



**Figure 19. Source to Drain Diode Forward Voltage vs. Source Current**

TYPICAL CHARACTERISTICS (Q2 N-CHANNEL) ( $T_J = 25^\circ\text{C}$  unless otherwise noted) (continued)

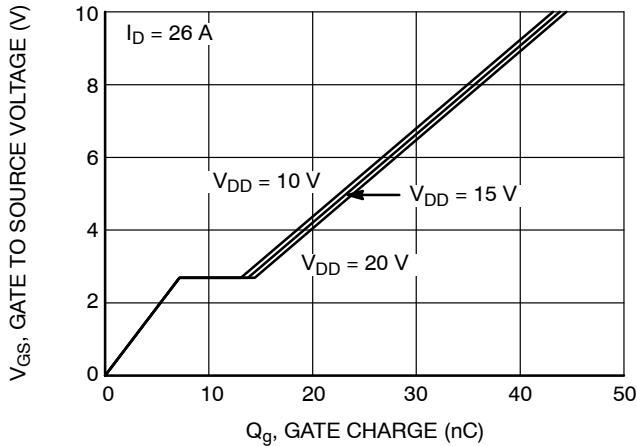


Figure 20. Gate Charge Characteristics

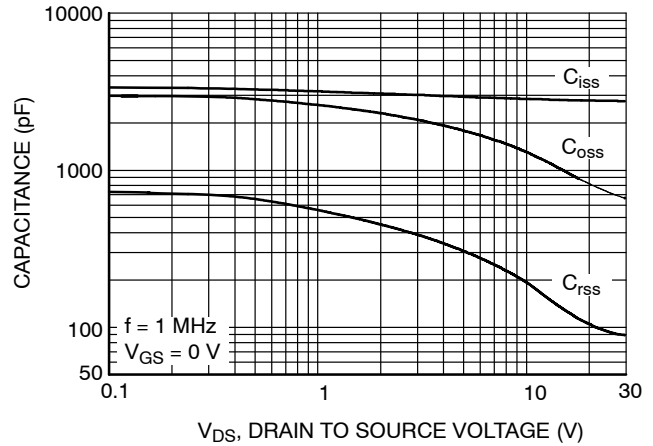


Figure 21. Capacitance vs. Drain to Source Voltage

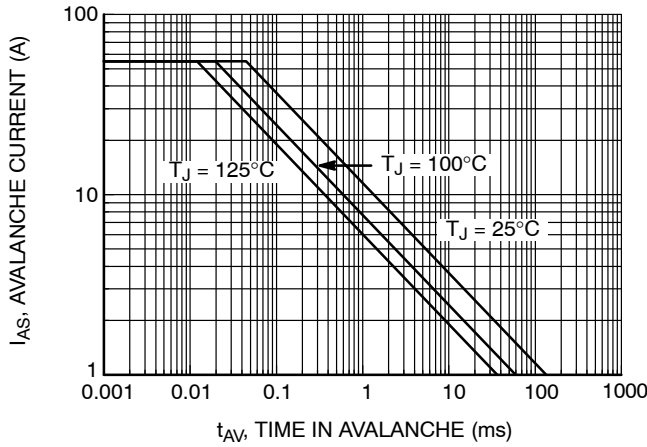


Figure 22. Unclamped Inductive Switching Capability

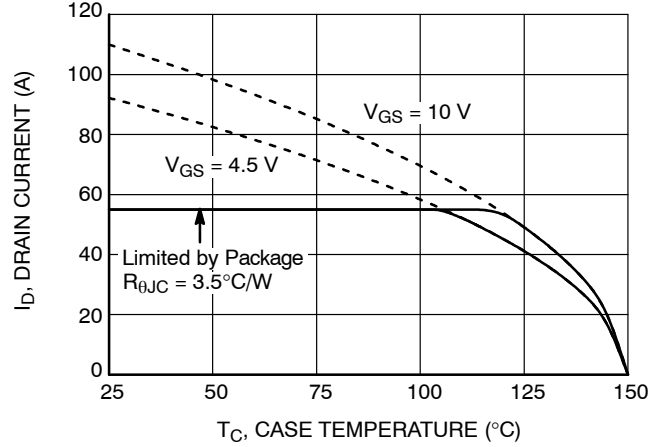


Figure 23. Maximum Continuous Drain Current vs. Ambient Temperature

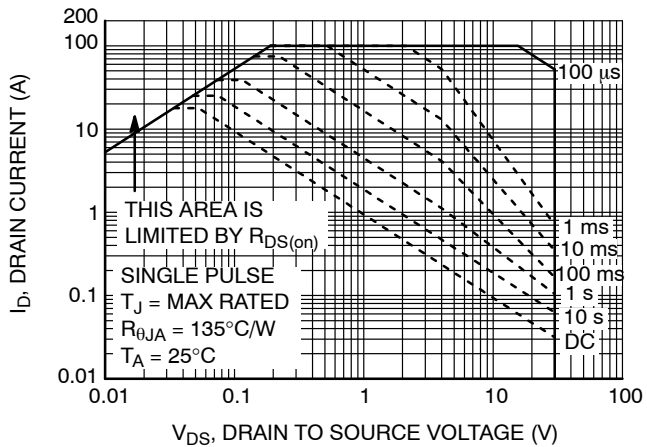


Figure 24. Forward Bias Safe Operating Area

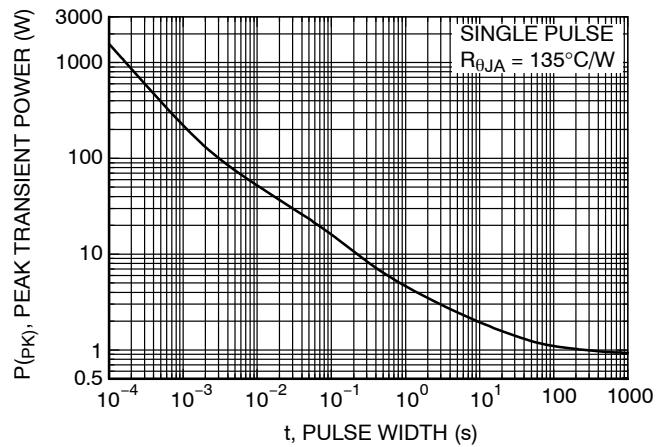
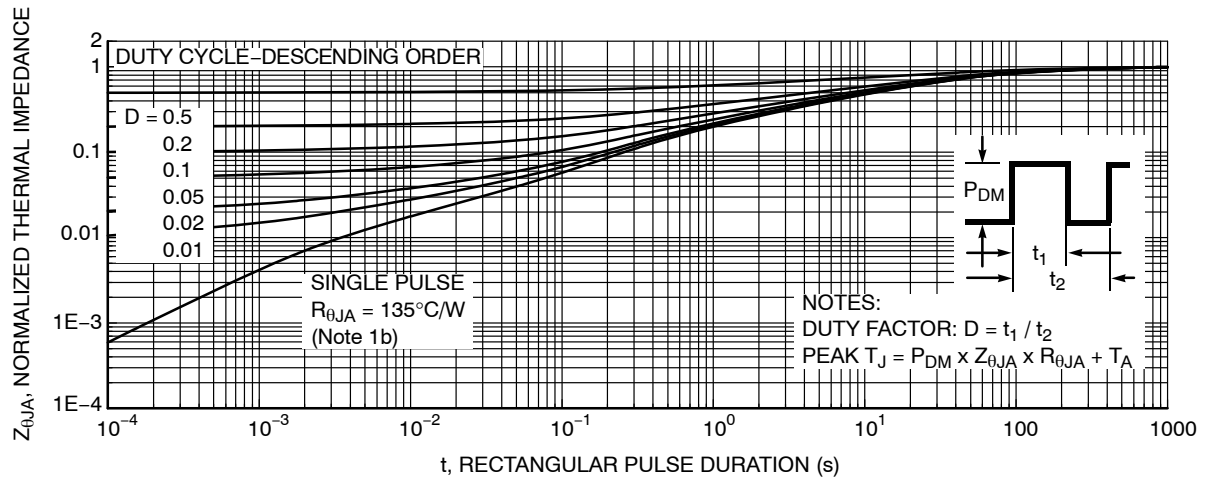


Figure 25. Single Pulse Maximum Power Dissipation

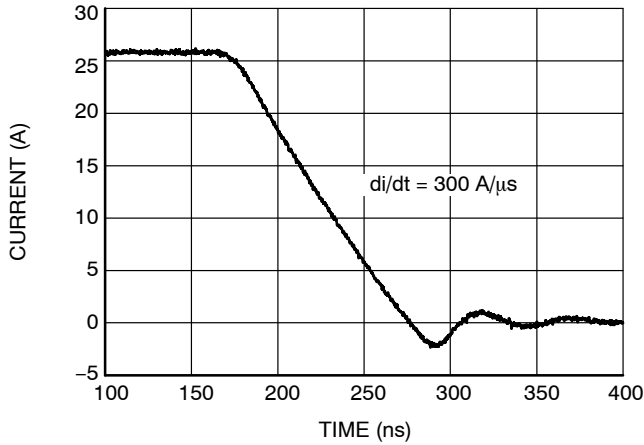
TYPICAL CHARACTERISTICS (Q2 N-CHANNEL) ( $T_J = 25^\circ\text{C}$  unless otherwise noted) (continued)

## TYPICAL CHARACTERISTICS (continued)

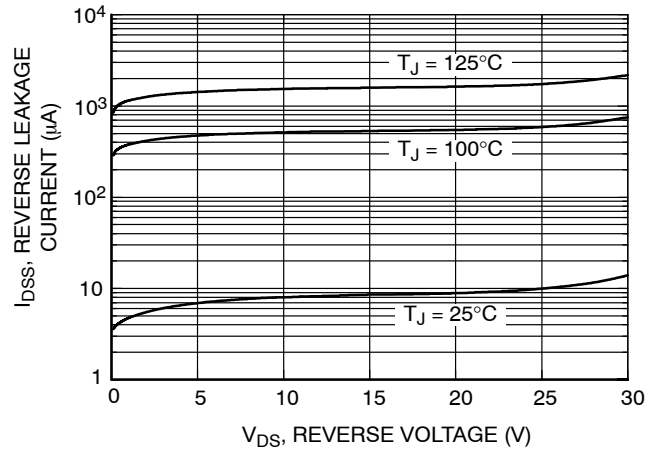
### SyncFET Schottky Body Diode Characteristics

onsemi's SyncFET process embeds a Schottky diode in parallel with POWERTRENCH MOSFET. This diode exhibits similar characteristics to a discrete external Schottky diode in parallel with a MOSFET. Figure 27 shows the reverse recovery characteristic of the FDPC8013S.

Schottky barrier diodes exhibit significant leakage at high temperature and high reverse voltage. This will increase the power in the device.



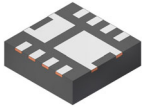
**Figure 27. FDPC8013S SyncFET Body Diode Reverse Recovery Characteristics**



**Figure 28. SyncFET Body Diode Reverse Leakage vs. Drain-Source Voltage**

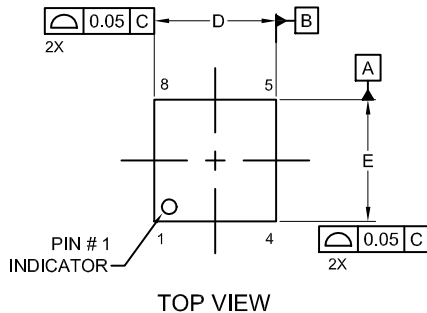
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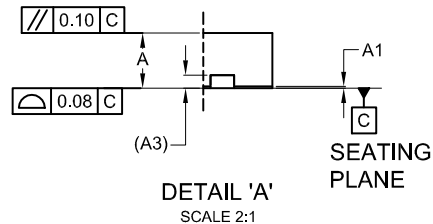


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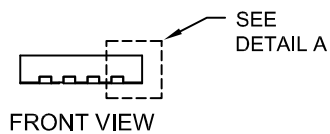


TOP VIEW

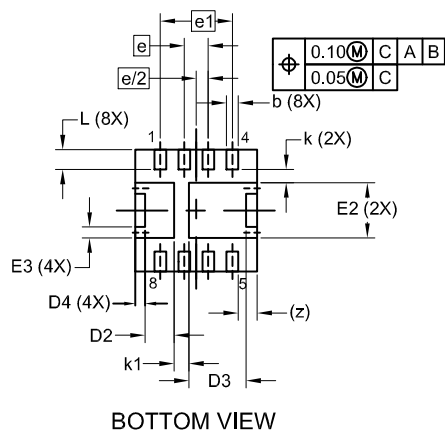


DETAIL 'A'

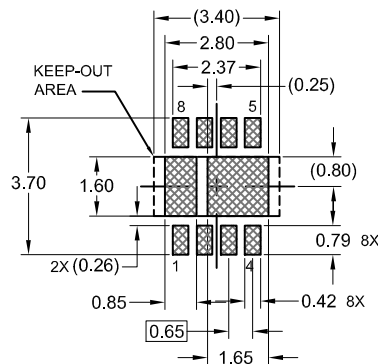
SCALE 2:1



FRONT VIEW



**BOTTOM VIEW**

LAND PATTERN  
RECOMMENDATION

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NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. COPLANARITY APPLIES TO THE EXPOSED PADS AS WELL AS THE TERMINALS.
4. DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH. MOLD FLASH OR BURRS DOES NOT EXCEED 0.10MM.
5. SEATING PLANE IS DEFINED BY THE TERMINALS. "A1" IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.
6. IT IS RECOMMENDED TO HAVE NO TRACES OR VIAS WITHIN THE KEEP OUT AREA.

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN         | NOM  | MAX  |
| A   | 0.70        | 0.75 | 0.80 |
| A1  | 0.00        | --   | 0.05 |
| A3  | 0.20 REF    |      |      |
| b   | 0.27        | 0.32 | 0.37 |
| D   | 3.20        | 3.30 | 3.40 |
| D2  | 0.69        | 0.79 | 0.89 |
| D3  | 1.45        | 1.55 | 1.65 |
| D4  | 0.16        | 0.26 | 0.36 |
| E   | 3.20        | 3.30 | 3.40 |
| E2  | 1.40        | 1.50 | 1.60 |
| E3  | 0.30 REF    |      |      |
| e   | 0.65 BSC    |      |      |
| e1  | 1.95 BSC    |      |      |
| e/2 | 0.325 BSC   |      |      |
| k   | 0.36 REF    |      |      |
| k1  | 0.40 REF    |      |      |
| L   | 0.44        | 0.54 | 0.64 |
| z   | 0.52 REF    |      |      |

|                         |                             |                                                                                                                                                                                     |
|-------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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