

# FDZ4670S

## N-Channel PowerTrench® SyncFET™ 30V, 25A, 2.4mΩ

### Features

- Max  $r_{DS(on)}$  = 2.4mΩ at  $V_{GS} = 10V$ ,  $I_D = 25A$
- Max  $r_{DS(on)}$  = 4.0mΩ at  $V_{GS} = 4.5V$ ,  $I_D = 19A$
- Ultra-thin package: less than 0.85mm height when mounted to PCB
- Outstanding thermal transfer characteristics
- Ultra-low gate charge x  $r_{DS(on)}$  product
- RoHS Compliant



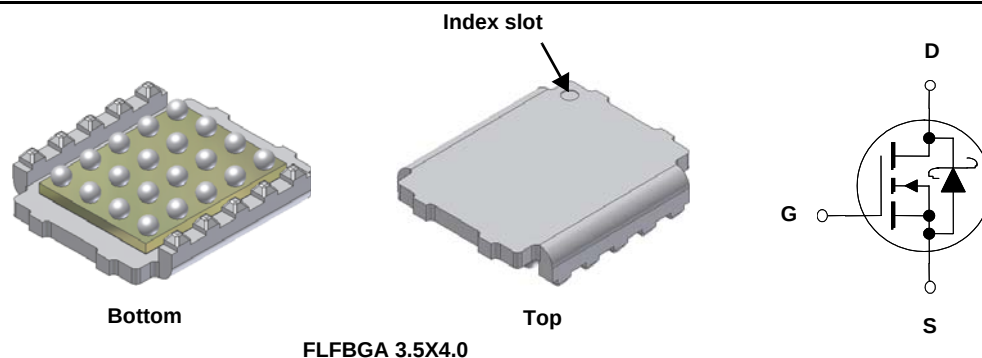
### General Description

Combining Fairchild's 30V PowerTrench® process with state-of-the-art BGA packaging, the FDZ4670S minimizes both PCB space and  $r_{DS(on)}$ . This BGA MOSFET embodies a breakthrough in packaging technology which enables the device to combine excellent thermal transfer characteristics, high current handling capacity, ultra-low profile packaging, low gate charge and low  $r_{DS(on)}$  incorporating SyncFET technology. This device has the added benefit of an efficient monolithic Schottky body diode to reduce  $T_{rr}$  and diode forward voltage.

This MOSFET feature faster switching and lower gate charge than other MOSFETs with comparable  $r_{DS(on)}$  specifications resulting in DC/DC power supply designs and POL converters with higher overall efficiency.

### Applications

- DC - DC Conversion
- POL converters



### MOSFET Maximum Ratings $T_A = 25^\circ\text{C}$ unless otherwise noted

| Symbol         | Parameter                                                    | Ratings     | Units            |
|----------------|--------------------------------------------------------------|-------------|------------------|
| $V_{DS}$       | Drain to Source Voltage                                      | 30          | V                |
| $V_{GS}$       | Gate to Source Voltage                                       | ±20         | V                |
| $I_D$          | Drain Current -Continuous $T_A = 25^\circ\text{C}$ (Note 1a) | 25          | A                |
|                | -Pulsed                                                      | 107         |                  |
| $P_D$          | Power Dissipation $T_A = 25^\circ\text{C}$ (Note 1a)         | 2.5         | W                |
|                | Power Dissipation $T_A = 25^\circ\text{C}$ (Note 1b)         | 1.25        |                  |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range             | -55 to +150 | $^\circ\text{C}$ |

### Thermal Characteristics

|                 |                                                   |      |                    |
|-----------------|---------------------------------------------------|------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case              | 0.85 | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Note 1a) | 50   |                    |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Note 1b) | 100  |                    |

### Package Marking and Ordering Information

| Device Marking | Device   | Package        | Reel Size | Tape Width | Quantity   |
|----------------|----------|----------------|-----------|------------|------------|
| 4670S          | FDZ4670S | FLFBGA 3.5X4.0 | 13"       | 12mm       | 3000 units |

**Electrical Characteristics**  $T_J = 25^\circ\text{C}$  unless otherwise noted

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

**Off Characteristics**

|                                      |                                           |                                                       |    |    |           |                      |
|--------------------------------------|-------------------------------------------|-------------------------------------------------------|----|----|-----------|----------------------|
| $BV_{DSS}$                           | Drain to Source Breakdown Voltage         | $I_D = 1\text{mA}$ , $V_{GS} = 0\text{V}$             | 30 |    |           | V                    |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 1\text{mA}$ , referenced to $25^\circ\text{C}$ |    | 25 |           | mV/ $^\circ\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{GS} = 0\text{V}$ , $V_{DS} = 24\text{V}$ ,        |    |    | 500       | $\mu\text{A}$        |
| $I_{GSS}$                            | Gate to Source Leakage Current            | $V_{GS} = \pm 20\text{V}$ , $V_{DS} = 0\text{V}$      |    |    | $\pm 100$ | nA                   |

**On Characteristics**

|                                        |                                                          |                                                                        |     |      |     |                      |
|----------------------------------------|----------------------------------------------------------|------------------------------------------------------------------------|-----|------|-----|----------------------|
| $V_{GS(th)}$                           | Gate to Source Threshold Voltage                         | $V_{GS} = V_{DS}$ , $I_D = 1\text{mA}$                                 | 1.0 | 1.8  | 3.0 | V                    |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate to Source Threshold Voltage Temperature Coefficient | $I_D = 1\text{mA}$ , referenced to $25^\circ\text{C}$                  |     | -3.6 |     | mV/ $^\circ\text{C}$ |
| $r_{DS(on)}$                           | Static Drain to Source On Resistance                     | $V_{GS} = 10\text{V}$ , $I_D = 25\text{A}$                             |     | 1.7  | 2.4 | m $\Omega$           |
|                                        |                                                          | $V_{GS} = 4.5\text{V}$ , $I_D = 19\text{A}$                            |     | 2.8  | 4.0 |                      |
|                                        |                                                          | $V_{GS} = 10\text{V}$ , $I_D = 25\text{A}$ , $T_J = 125^\circ\text{C}$ |     | 2.7  | 3.6 |                      |
| $g_{FS}$                               | Forward Transconductance                                 | $V_{DD} = 10\text{V}$ , $I_D = 25\text{A}$                             |     | 118  |     | S                    |

**Dynamic Characteristics**

|           |                              |                                                                     |  |      |      |          |
|-----------|------------------------------|---------------------------------------------------------------------|--|------|------|----------|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 15\text{V}$ , $V_{GS} = 0\text{V}$ ,<br>$f = 1\text{MHz}$ |  | 2890 | 3845 | pF       |
| $C_{oss}$ | Output Capacitance           |                                                                     |  | 1610 | 2145 | pF       |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                     |  | 160  | 240  | pF       |
| $R_g$     | Gate Resistance              | $f = 1\text{MHz}$                                                   |  | 1.0  |      | $\Omega$ |

**Switching Characteristics**

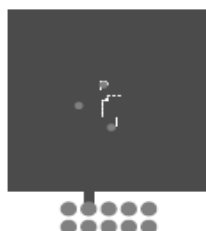
|              |                               |                                                                                             |  |     |    |    |
|--------------|-------------------------------|---------------------------------------------------------------------------------------------|--|-----|----|----|
| $t_{d(on)}$  | Turn-On Delay Time            | $V_{DD} = 15\text{V}$ , $I_D = 25\text{A}$ ,<br>$V_{GS} = 10\text{V}$ , $R_{GEN} = 6\Omega$ |  | 13  | 23 | ns |
| $t_r$        | Rise Time                     |                                                                                             |  | 4.5 | 10 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time           |                                                                                             |  | 31  | 50 | ns |
| $t_f$        | Fall Time                     |                                                                                             |  | 3.1 | 10 | ns |
| $Q_g$        | Total Gate Charge             | $V_{GS} = 10\text{V}$                                                                       |  | 49  | 69 | nC |
| $Q_{gs}$     | Gate to Source Charge         | $V_{DD} = 15\text{V}$                                                                       |  | 9.1 |    | nC |
| $Q_{gd}$     | Gate to Drain "Miller" Charge | $I_D = 25\text{A}$                                                                          |  | 7.6 |    | nC |

**Drain-Source Diode Characteristics**

|          |                                       |                                                        |  |     |     |    |
|----------|---------------------------------------|--------------------------------------------------------|--|-----|-----|----|
| $V_{SD}$ | Source to Drain Diode Forward Voltage | $V_{GS} = 0\text{V}$ , $I_S = 3.5\text{A}$ (Note 2)    |  | 0.4 | 0.7 | V  |
| $t_{rr}$ | Reverse Recovery Time                 | $I_F = 25\text{A}$ , $di/dt = 300\text{A}/\mu\text{s}$ |  | 37  |     | ns |
| $Q_{rr}$ | Reverse Recovery Charge               |                                                        |  | 46  |     | nC |

## NOTES:

1.  $R_{\theta JA}$  is determined with the device mounted on a  $1\text{in}^2$  pad 2 oz copper pad on a  $1.5 \times 1.5\text{in.}$  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.  $50^\circ\text{C}/\text{W}$  when mounted on a  $1\text{in}^2$  pad of 2 oz copper.



b.  $100^\circ\text{C}/\text{W}$  when mounted on a minimum pad of 2 oz copper.

2. Pulse Test: Pulse Width  $< 300\mu\text{s}$ , Duty cycle  $< 2.0\%$ .

# Typical Characteristics $T_J = 25^\circ\text{C}$ unless otherwise noted

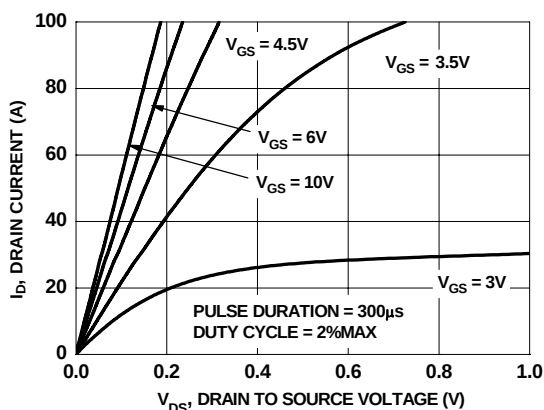


Figure 1. On-Region Characteristics

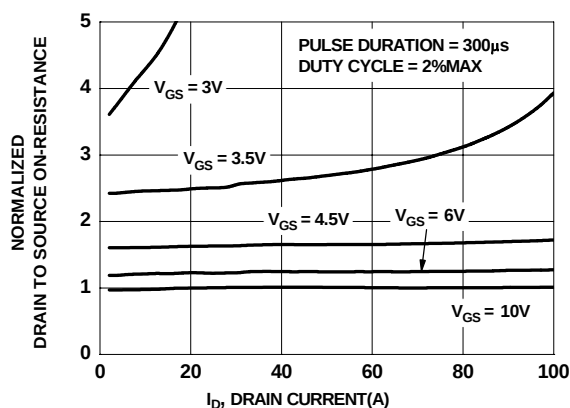


Figure 2. Normalized On-Resistance vs Drain Current and Gate Voltage

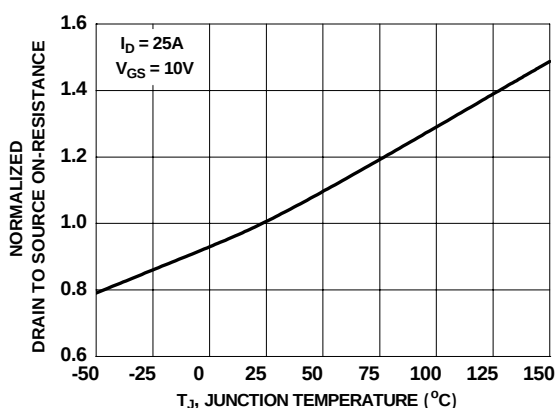


Figure 3. Normalized On-Resistance vs Junction Temperature

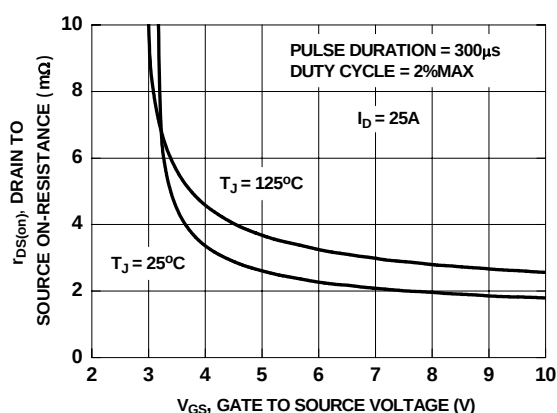


Figure 4. On-Resistance vs Gate to Source Voltage

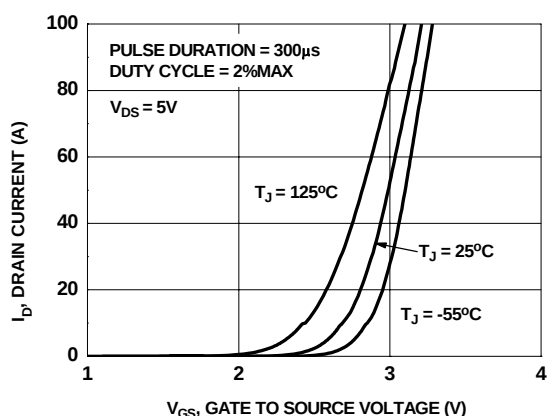


Figure 5. Transfer Characteristics

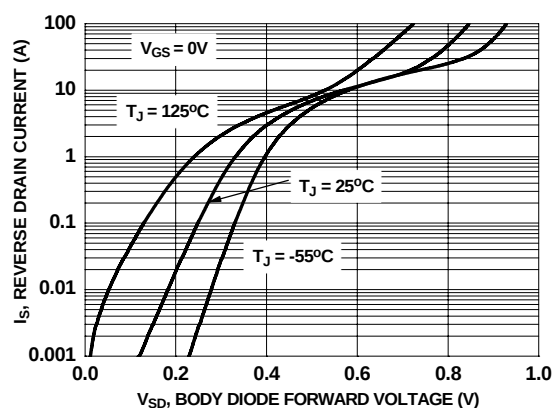


Figure 6. Source to Drain Diode Forward Voltage vs Source Current

# Typical Characteristics $T_J = 25^\circ\text{C}$ unless otherwise noted

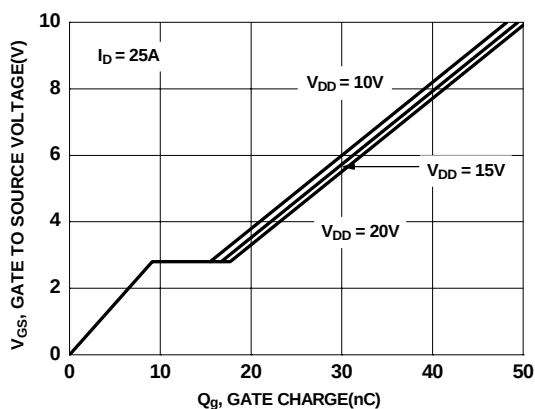


Figure 7. Gate Charge Characteristics

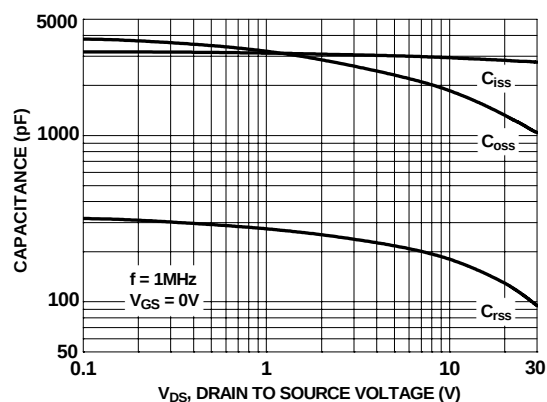


Figure 8. Capacitance vs Drain to Source Voltage

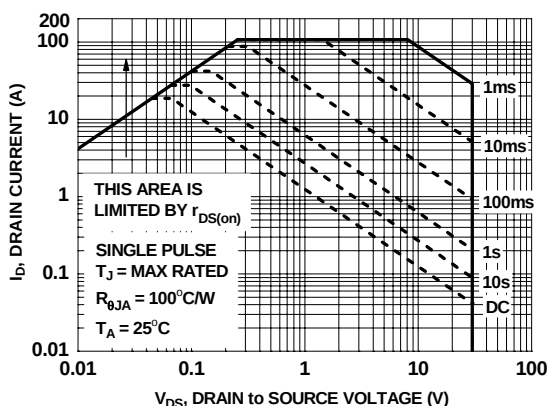


Figure 9. Forward Bias Safe Operating Area

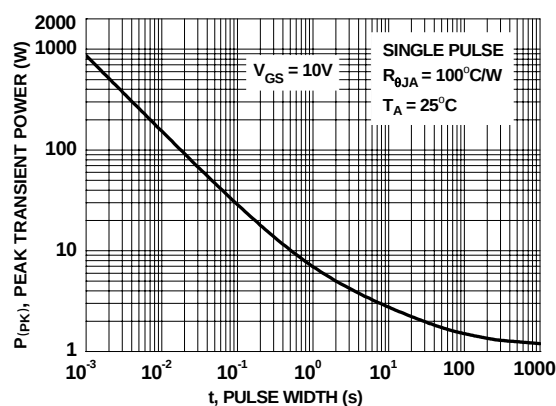


Figure 10. Single Pulse Maximum Power Dissipation

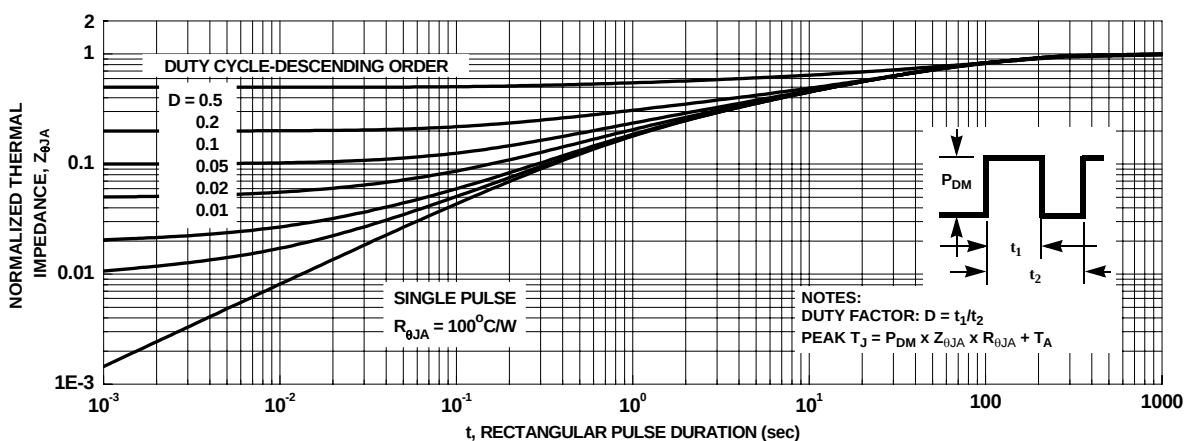
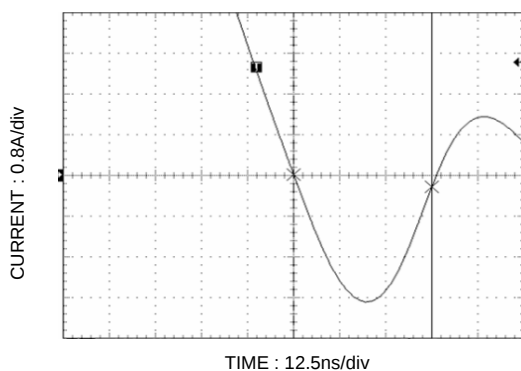


Figure 11. Transient Thermal Response Curve

## Typical Characteristics (continued)

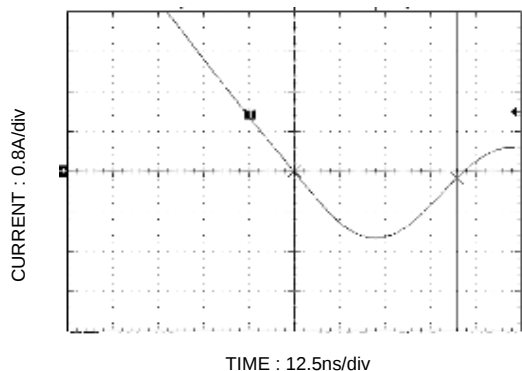
### SyncFET Schottky Body Diode Characteristics

Fairchild'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 22 shows the reverse recovery characteristic of the FDZ4670S.



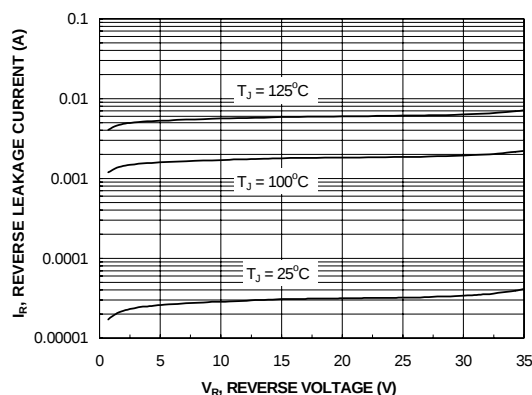
**Figure 22. FDZ4670S SyncFET body diode reverse recovery characteristic**

For comparison purposes, Figure 23 shows the reverse recovery characteristics of the body diode of an equivalent size MOSFET produced without SyncFET (FDZ4670).



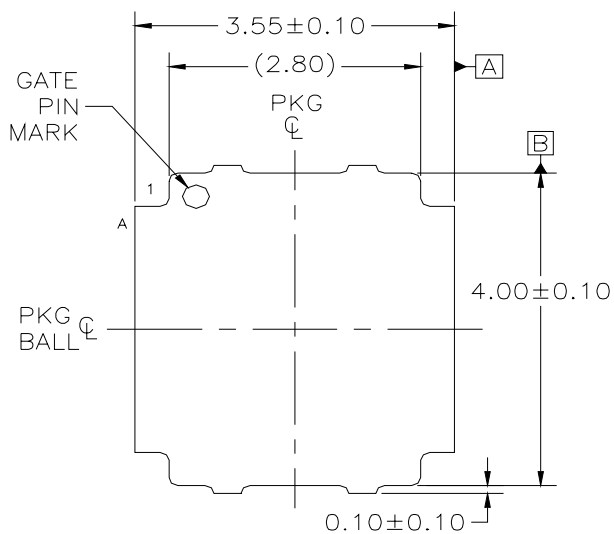
**Figure 23. Non-SyncFET (FDZ4670) body diode reverse recovery characteristic**

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

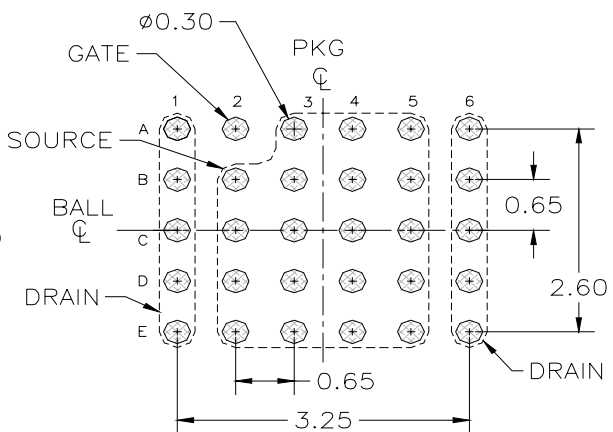


**Figure 24. SyncFET body diode reverse leakage versus drain-source voltage and temperature**

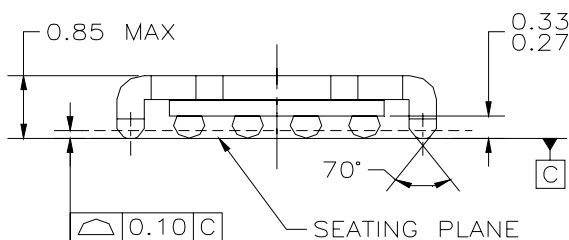
## Dimensional Outline and Pad Layout



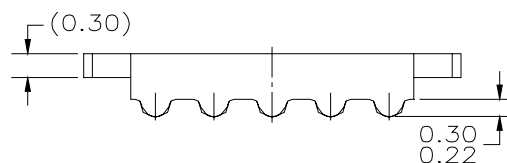
TOP VIEW



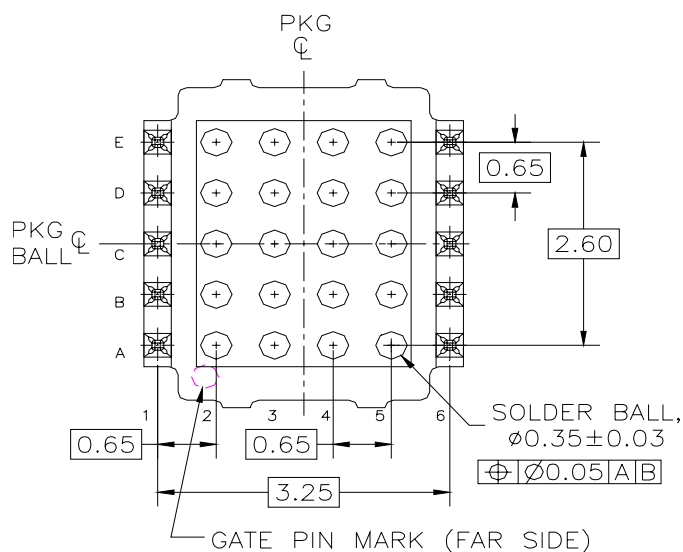
LAND PATTERN RECOMMENDATION



FRONT VIEW



SIDE VIEW



BOTTOM VIEW

BGA020CREVA

## NOTES: UNLESS OTHERWISE SPECIFIED

- A) ALL DIMENSIONS ARE IN MILLIMETERS.  
 B) NO JEDEC REGISTRATION REFERENCE AS OF MARCH 2006.  
 C) TERMINAL CONFIGURATION TABLE

| POSITION                                                             | DESIGNATION | TYPE           |
|----------------------------------------------------------------------|-------------|----------------|
| A1,B1,C1,D1,E1,<br>A6,B6,C6,D6,E6                                    | DRAIN       | COPPER<br>STUD |
| A2                                                                   | GATE        | SOLDER<br>BALL |
| A3,A4,A5,B2,B3,<br>B4,B5,C2,C3,C4,<br>C5,D2,D3,D4,D5,<br>E2,E3,E4,E5 | SOURCE      |                |

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| FlashWriter <sup>®</sup> *                                                        | OPTOPLANAR <sup>®</sup>                                                           | SuperSOT <sup>™</sup> -6               | VCX <sup>™</sup>                     |
|                                                                                   |  | SuperSOT <sup>™</sup> -8               |                                      |

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| Datasheet Identification | Product Status         | Definition                                                                                                                                                                                               |
|--------------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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