

# MOSFET – Complementary, POWER trench<sup>®</sup>

60 V

## FDS4559

### General Description

This complementary MOSFET device is produced using onsemi's advanced PowerTrench process that has been especially tailored to minimize the on-state resistance and yet maintain low gate charge for superior switching performance.

### Features

- Q1: N-Channel
  - 4.5 A, 60 V
  - $R_{DS(on)} = 55\text{ m}\Omega @ V_{GS} = 10\text{ V}$
  - $R_{DS(on)} = 75\text{ m}\Omega @ V_{GS} = 4.5\text{ V}$
- Q2: P-Channel
  - 3.5 A, -60 V
  - $R_{DS(on)} = 105\text{ m}\Omega @ V_{GS} = -10\text{ V}$
  - $R_{DS(on)} = 135\text{ m}\Omega @ V_{GS} = -4.5\text{ V}$

### Applications

- DC/DC converter
- Power management
- LCD backlight inverter
- This is a Pb-Free and Halide Free Device

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

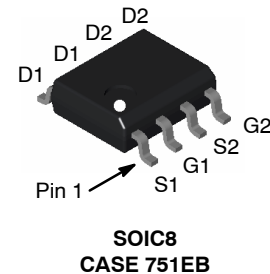
| Symbol         | Parameter                                        | Q1                   | Q2       | Unit             |
|----------------|--------------------------------------------------|----------------------|----------|------------------|
| $V_{DSS}$      | Drain-Source Voltage                             | 60                   | -60      | V                |
| $V_{GSS}$      | Gate-Source Voltage                              | $\pm 20$             | $\pm 20$ | V                |
| $I_D$          | Drain Current                                    | Continuous (Note 1a) | 4.5      | A                |
|                |                                                  | Pulsed               | 20       |                  |
| $P_D$          | Power Dissipation for Dual Operation             |                      | 2        | W                |
|                | Power Dissipation for Single Operation           | (Note 1a)            | 1.6      |                  |
|                |                                                  | (Note 1b)            | 1.2      |                  |
|                |                                                  | (Note 1c)            | 1        |                  |
| $T_J, T_{STG}$ | 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.

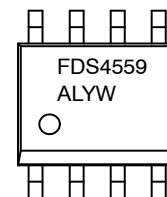
### THERMAL CHARACTERISTICS

| Symbol          | Parameter                                         | Value | Unit               |
|-----------------|---------------------------------------------------|-------|--------------------|
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (Note 1a) | 78    | $^\circ\text{C/W}$ |
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case (Note 1)     | 40    | $^\circ\text{C/W}$ |

| $V_{DSS}$          | $R_{DS(on)}$ Max        | $I_D$ Max |
|--------------------|-------------------------|-----------|
| N-Channel<br>60 V  | 55 m $\Omega$ @ 10 V    | 4.5 A     |
|                    | 75 m $\Omega$ @ 4.5 V   |           |
| P-Channel<br>-60 V | 105 m $\Omega$ @ -10 V  | -3.5 A    |
|                    | 135 m $\Omega$ @ -4.5 V |           |

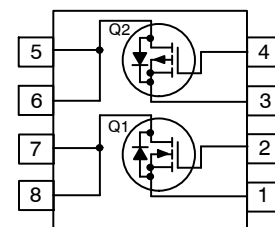


### MARKING DIAGRAM



FDS4559 = Specific Device Code  
 A = Assembly Site  
 L = Wafer Lot Number  
 YW = Assembly Start Week

### N-Channel / P-Channel



### ORDERING INFORMATION

| Device  | Package                            | Shipping <sup>†</sup> |
|---------|------------------------------------|-----------------------|
| FDS4559 | SOIC8<br>(Pb-Free,<br>Halide Free) | 2500 /<br>Tape & Reel |

<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](http://BRD8011/D).

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

| Symbol    | Parameter                                  | Test Condition                               | Typ | Min | Typ | Max | Unit |
|-----------|--------------------------------------------|----------------------------------------------|-----|-----|-----|-----|------|
| $W_{DSS}$ | Single Pulse Drain–Source Avalanche Energy | $V_{DD} = 30\text{ V}$ , $I_D = 25\text{ A}$ | Q1  | –   | –   | 90  | V    |
| $I_{AR}$  | Maximum Drain–Source Avalanche Current     |                                              | Q1  | –   | –   | 4.5 | V    |

**DRAIN–SOURCE AVALANCHE RATINGS** (Note 1)

|           |                                            |                                              |    |   |   |     |   |
|-----------|--------------------------------------------|----------------------------------------------|----|---|---|-----|---|
| $W_{DSS}$ | Single Pulse Drain–Source Avalanche Energy | $V_{DD} = 30\text{ V}$ , $I_D = 25\text{ A}$ | Q1 | – | – | 90  | V |
| $I_{AR}$  | Maximum Drain–Source Avalanche Current     |                                              | Q1 | – | – | 4.5 | V |

**OFF CHARACTERISTICS**

|                                      |                                           |                                                                                                                                         |          |           |           |                        |                      |
|--------------------------------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|----------|-----------|-----------|------------------------|----------------------|
| $BV_{DSS}$                           | Drain–Source Breakdown Voltage            | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$<br>$V_{GS} = 0\text{ V}$ , $I_D = -250\text{ }\mu\text{A}$                       | Q1<br>Q2 | 60<br>–60 | –<br>–    | –<br>–                 | V                    |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$<br>$I_D = -250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$ | Q1<br>Q2 | –<br>–    | 58<br>–49 | –<br>–                 | mV/ $^\circ\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = 48\text{ V}$ , $V_{GS} = 0\text{ V}$<br>$V_{DS} = -48\text{ V}$ , $V_{GS} = 0\text{ V}$                                       | Q1<br>Q2 | –<br>–    | –<br>–    | 1<br>–1                | $\mu\text{A}$        |
| $I_{GSS}$                            | Gate–Body Leakage                         | $V_{GS} = \pm 20\text{ V}$ , $V_{DS} = 0\text{ V}$<br>$V_{GS} = \pm 20\text{ V}$ , $V_{DS} = 0\text{ V}$                                | Q1<br>Q2 | –<br>–    | –<br>–    | $\pm 100$<br>$\pm 100$ | nA                   |

**ON CHARACTERISTICS** (Note 2)

|                                        |                                                |                                                                                                                                                                                    |          |             |                  |                   |                      |
|----------------------------------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|------------------|-------------------|----------------------|
| $V_{GS(th)}$                           | Gate Threshold Voltage                         | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$<br>$V_{DS} = V_{GS}$ , $I_D = -250\text{ }\mu\text{A}$                                                                          | Q1<br>Q2 | 1<br>–1     | 2.2<br>–1.6      | 3<br>–3           | V                    |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$<br>$I_D = -250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$                                            | Q1<br>Q2 | –<br>–      | –5.5<br>4        | –<br>–            | mV/ $^\circ\text{C}$ |
| $R_{DS(on)}$                           | Static Drain–Source On–Resistance              | $V_{GS} = 10\text{ V}$ , $I_D = 4.5\text{ A}$<br>$V_{GS} = 10\text{ V}$ , $I_D = 4.5\text{ A}$ , $T_j = 125^\circ\text{C}$<br>$V_{GS} = 4.5\text{ V}$ , $I_D = 4\text{ A}$         | Q1       | –<br>–<br>– | 42<br>72<br>55   | 55<br>94<br>75    | m $\Omega$           |
|                                        |                                                | $V_{GS} = -10\text{ V}$ , $I_D = -3.5\text{ A}$<br>$V_{GS} = -10\text{ V}$ , $I_D = -3.5\text{ A}$ , $T_j = 125^\circ\text{C}$<br>$V_{GS} = -4.5\text{ V}$ , $I_D = -3.1\text{ A}$ | Q2       | –<br>–<br>– | 82<br>130<br>105 | 105<br>190<br>135 | m $\Omega$           |
| $I_{D(on)}$                            | On–State Drain Current                         | $V_{GS} = 10\text{ V}$ , $V_{DS} = 5\text{ V}$<br>$V_{GS} = -10\text{ V}$ , $V_{DS} = -5\text{ V}$                                                                                 | Q1<br>Q2 | 20<br>–20   | –<br>–           | –<br>–            | A                    |
| $g_{FS}$                               | Forward Transconductance                       | $V_{DS} = 10\text{ V}$ , $I_D = 4.5\text{ A}$<br>$V_{DS} = -5\text{ V}$ , $I_D = -3.5\text{ A}$                                                                                    | Q1<br>Q2 | –<br>–      | 14<br>9          | –<br>–            | S                    |

**DYNAMIC CHARACTERISTICS**

|           |                              |                                                                                 |          |        |            |        |    |
|-----------|------------------------------|---------------------------------------------------------------------------------|----------|--------|------------|--------|----|
| $C_{iss}$ | Input Capacitance            | Q1<br>$V_{DS} = 25\text{ V}$ , $V_{GS} = 0\text{ V}$ ,<br>$f = 1.0\text{ Mhz}$  | Q1<br>Q2 | –<br>– | 650<br>759 | –<br>– | pF |
| $C_{oss}$ | Output Capacitance           | Q2<br>$V_{DS} = -30\text{ V}$ , $V_{GS} = 0\text{ V}$ ,<br>$f = 1.0\text{ MHz}$ | Q1<br>Q2 | –<br>– | 80<br>90   | –<br>– | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                                 | Q1<br>Q2 | –<br>– | 35<br>39   | –<br>– | pF |

**SWITCHING CHARACTERISTICS** (Note 2)

|              |                     |                                                                                                                |          |        |            |          |    |
|--------------|---------------------|----------------------------------------------------------------------------------------------------------------|----------|--------|------------|----------|----|
| $t_{d(on)}$  | Turn–On Delay Time  | Q1<br>$V_{DD} = 30\text{ V}$ , $I_D = 1\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ , $R_{GEN} = 6\text{ }\Omega$    | Q1<br>Q2 | –<br>– | 11<br>7    | 20<br>14 | ns |
| $t_r$        | Turn–On Rise Time   | Q2<br>$V_{DD} = -30\text{ V}$ , $I_D = -1\text{ A}$ ,<br>$V_{GS} = -10\text{ V}$ , $R_{GEN} = 6\text{ }\Omega$ | Q1<br>Q2 | –<br>– | 8<br>10    | 18<br>20 | ns |
| $t_{d(off)}$ | Turn–Off Delay Time |                                                                                                                | Q1<br>Q2 | –<br>– | 19<br>19   | 35<br>34 | ns |
| $t_f$        | Turn–Off Fall Time  |                                                                                                                | Q1<br>Q2 | –<br>– | 6<br>12    | 15<br>22 | ns |
| $Q_g$        | Total Gate Charge   | Q1<br>$V_{DD} = 30\text{ V}$ , $I_D = 4.5\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$                                | Q1<br>Q2 | –<br>– | 12.5<br>15 | 18<br>21 | nC |
| $Q_{gs}$     | Gate–Source Charge  | Q2<br>$V_{DD} = -30\text{ V}$ , $I_D = -3.5\text{ A}$ ,<br>$V_{GS} = -10\text{ V}$                             | Q1<br>Q2 | –<br>– | 2.4<br>2.5 | –<br>–   | nC |
| $Q_{gd}$     | Gate–Drain Charge   |                                                                                                                | Q1<br>Q2 | –<br>– | 2.6<br>3.0 | –<br>–   | nC |

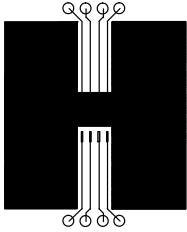
**ELECTRICAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

**DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS**

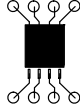
|          |                                                       |                                                                                                           |          |        |             |             |   |
|----------|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|----------|--------|-------------|-------------|---|
| $I_S$    | Maximum Continuous Drain-Source Diode Forward Current |                                                                                                           | Q1<br>Q2 | -<br>- | -<br>-      | 1.3<br>-1.3 | A |
| $V_{SD}$ | Drain-Source Diode Forward Voltage                    | $V_{GS} = 0\text{ V}, I_S = 1.3\text{ A}$ (Note 2)<br>$V_{GS} = 0\text{ V}, I_S = -1.3\text{ A}$ (Note 2) | Q1<br>Q2 | -<br>- | 0.8<br>-0.8 | 1.2<br>-1.2 | V |

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.

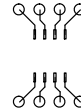
1.  $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a)  $78^\circ\text{C/W}$  when mounted on a  $0.5\text{ in}^2$  pad of 2 oz copper



b)  $125^\circ\text{C/W}$  when mounted on a  $.02\text{ in}^2$  pad of 2 oz copper



c)  $135^\circ\text{C/W}$  when mounted on a minimum pad

Scale 1:1 on letter size paper

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

## TYPICAL CHARACTERISTICS (Q2 P-CHANNEL)

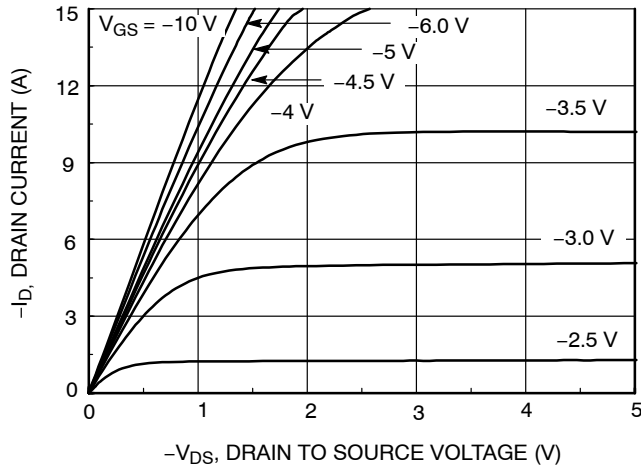


Figure 1. On-Region Characteristics

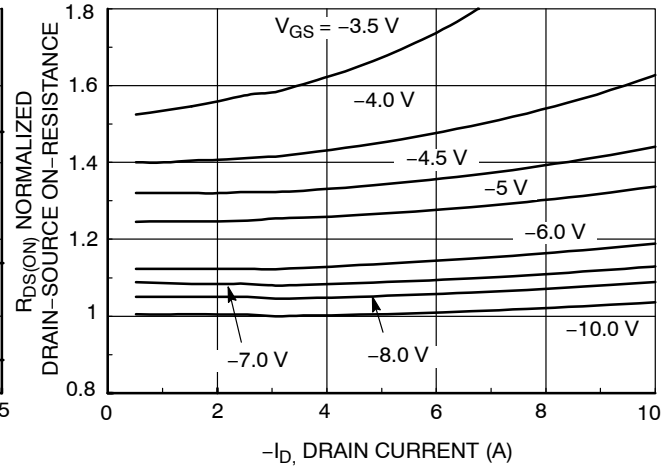


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage

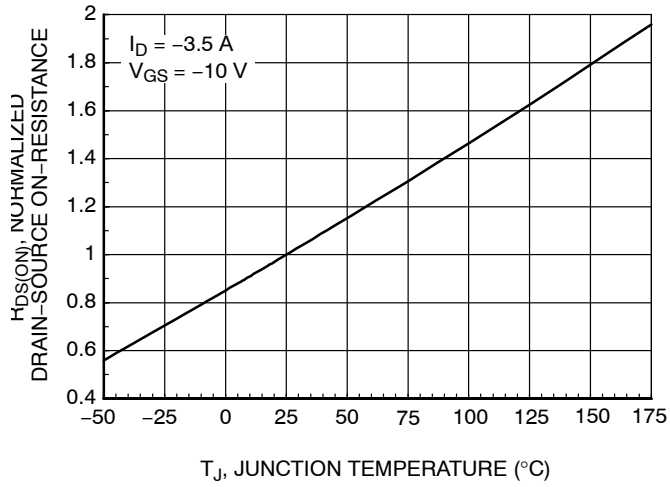


Figure 3. On-Resistance Variation with Temperature

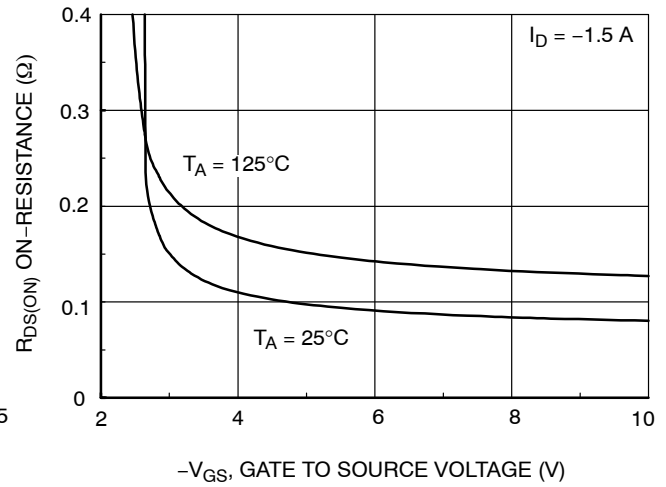


Figure 4. On-Resistance Variation with Gate-to-Source Voltage

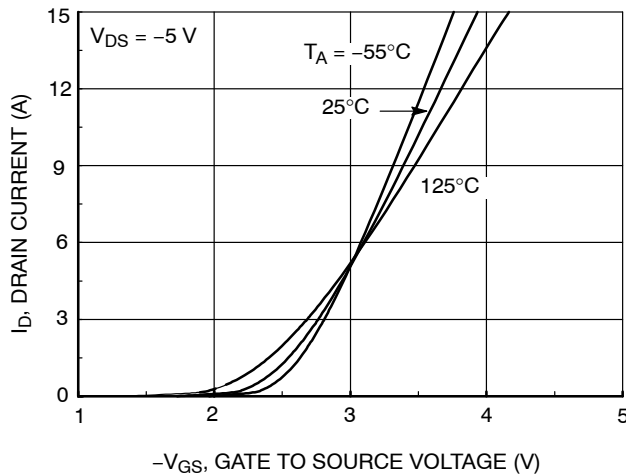


Figure 5. Transfer Characteristics

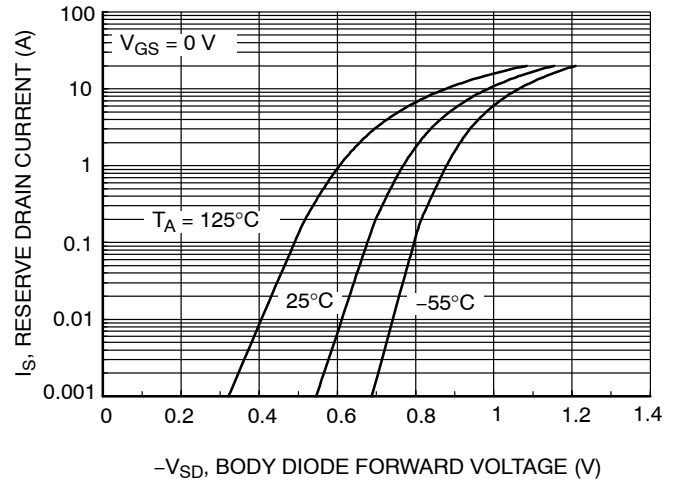


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

TYPICAL CHARACTERISTICS (Q2 P-CHANNEL) (continued)

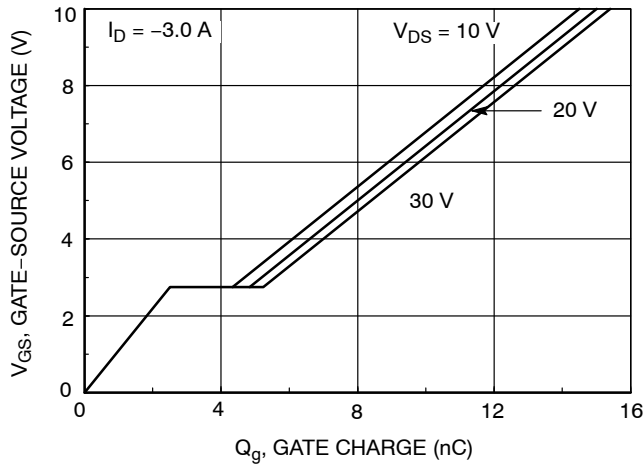


Figure 7. Gate Charge Characteristics

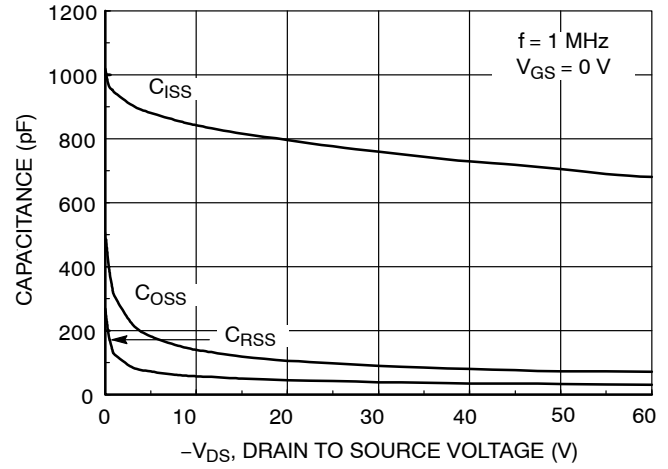


Figure 8. Capacitance Characteristics

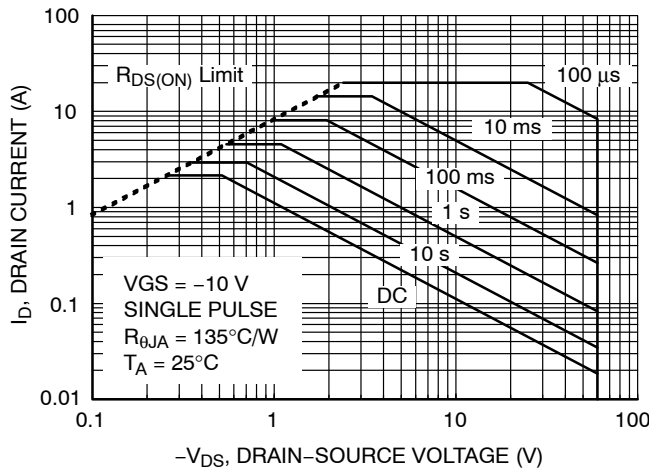


Figure 9. Maximum Safe Operating Area

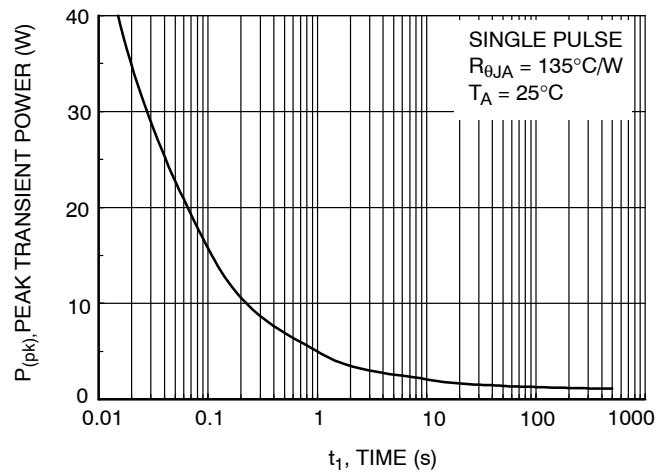


Figure 10. Single Pulse Maximum Power Dissipation

## TYPICAL CHARACTERISTICS (Q1 N-CHANNEL)

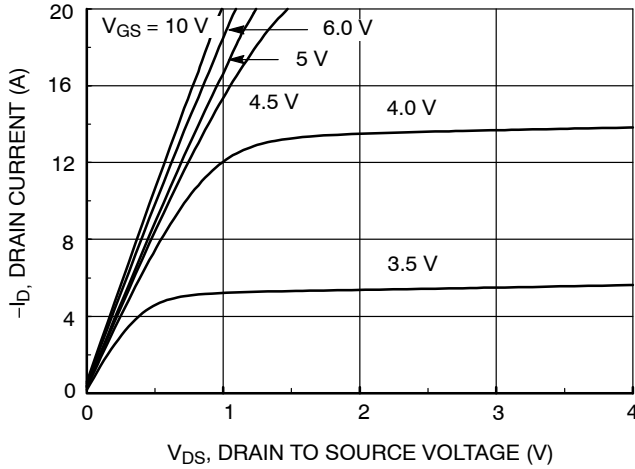


Figure 11. On-Region Characteristics

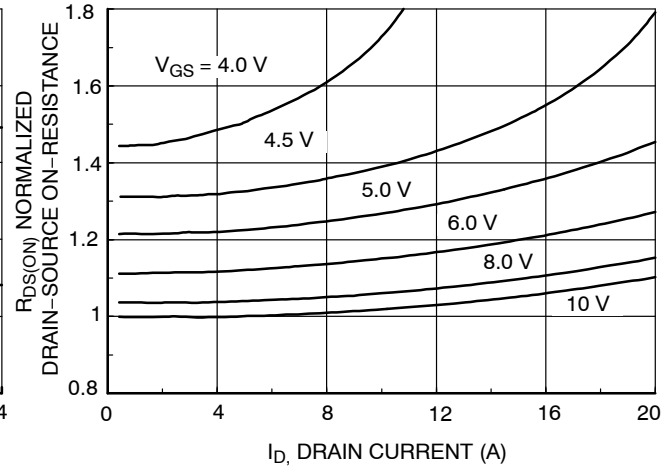


Figure 12. On-Resistance Variation with Drain Current and Gate Voltage

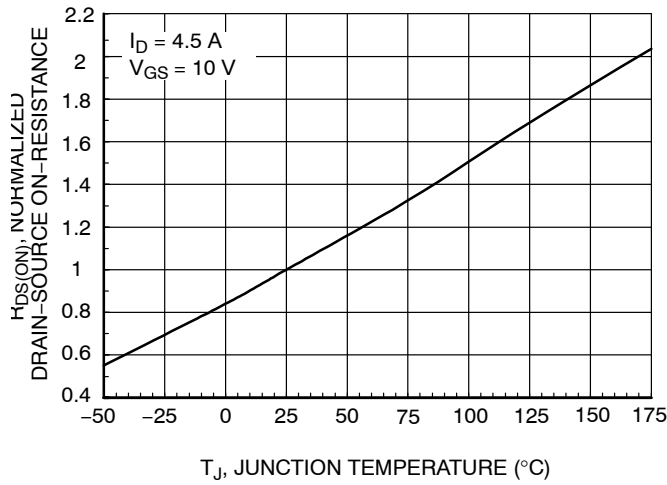


Figure 13. On-Resistance Variation with Temperature

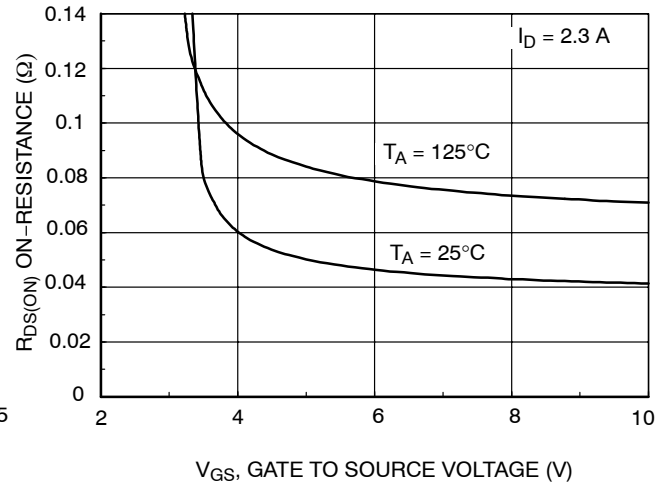


Figure 14. On-Resistance Variation with Gate-to-Source Voltage

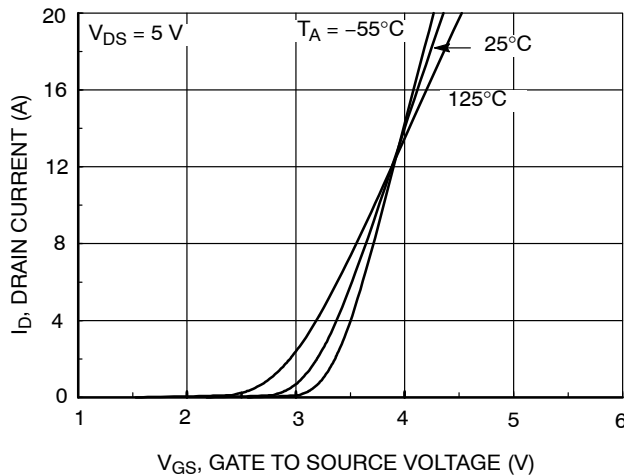


Figure 15. Transfer Characteristics

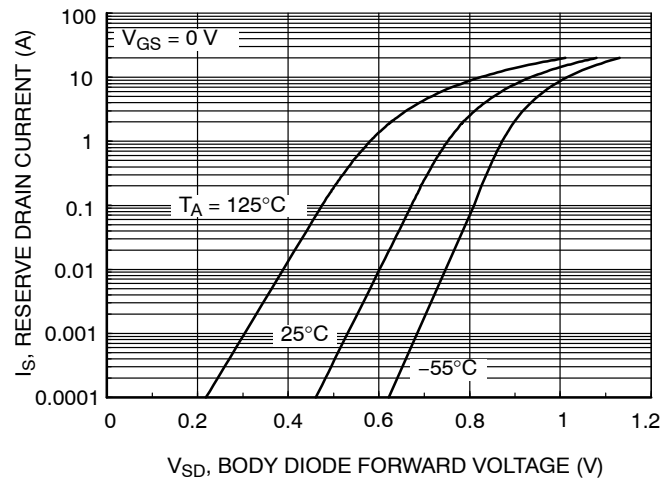


Figure 16. Body Diode Forward Voltage Variation with Source Current and Temperature

## TYPICAL CHARACTERISTICS (Q1 N-CHANNEL) (continued)

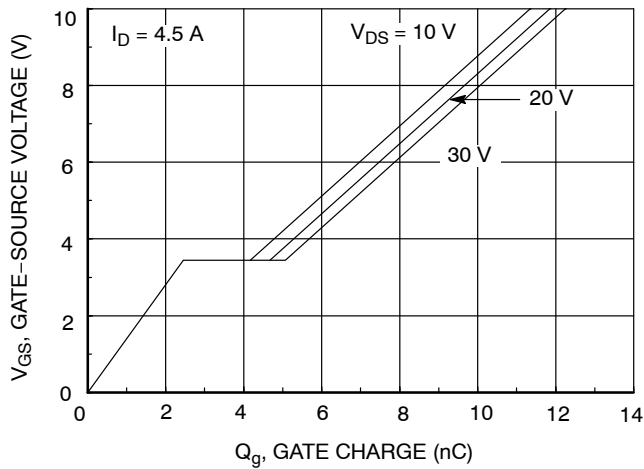


Figure 17. Gate Charge Characteristics

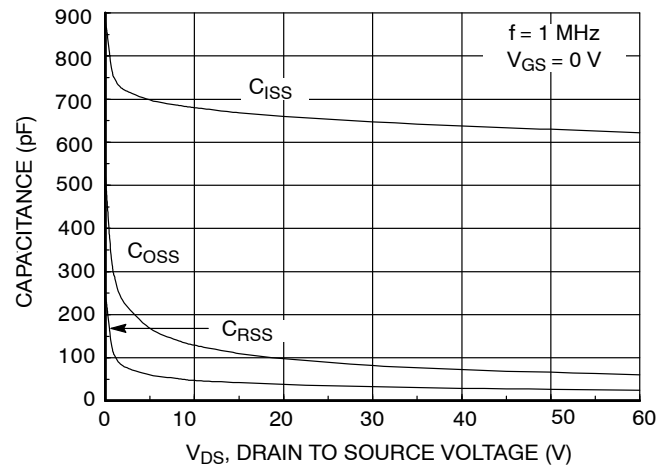


Figure 18. Capacitance Characteristics

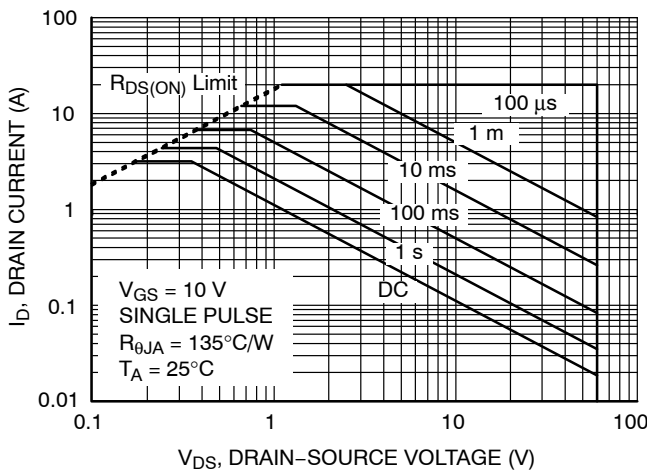


Figure 19. Maximum Safe Operating Area

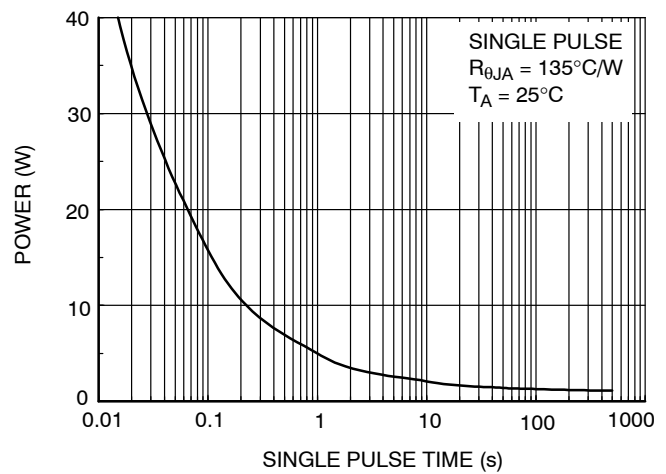


Figure 20. Single Pulse Maximum Power Dissipation

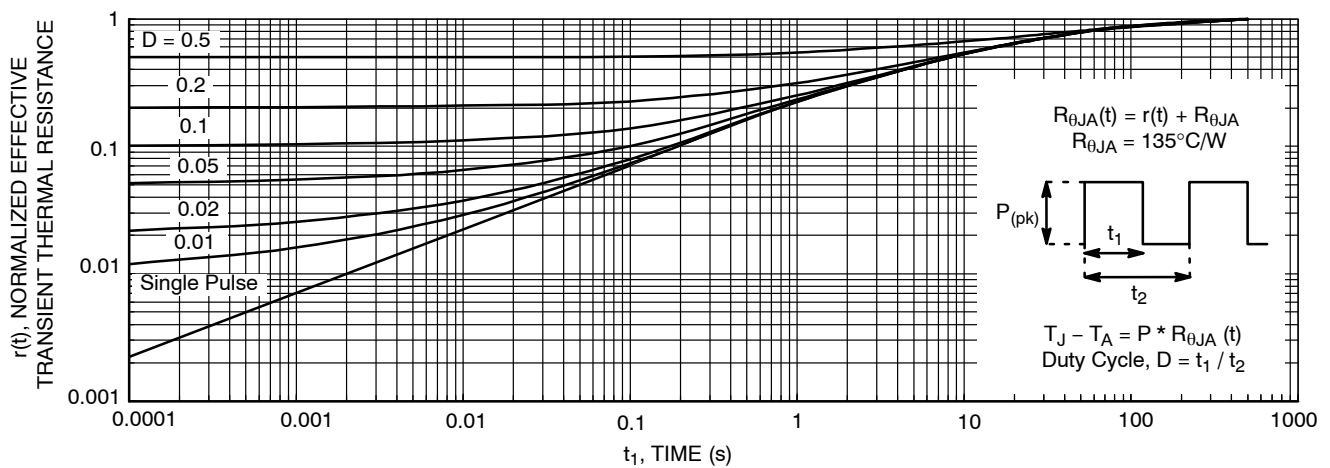


Figure 21. Transient Thermal Response Curve

Thermal characterization performed using the conditions described in Note 1c.  
Transient thermal response will change depending on the circuit board design.

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# MECHANICAL CASE OUTLINE

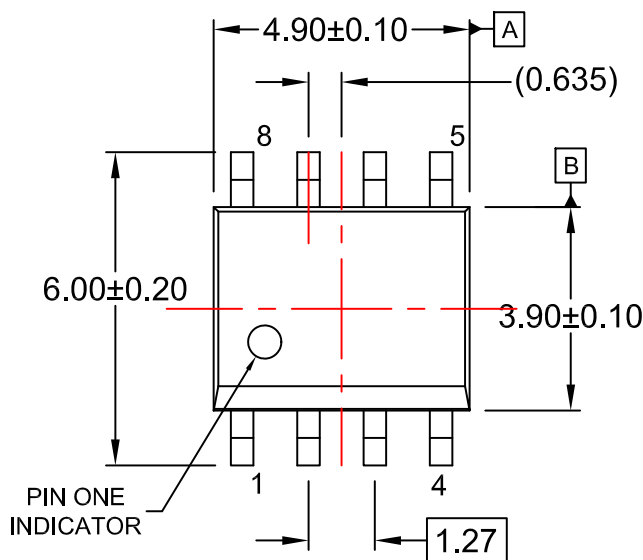
## PACKAGE DIMENSIONS

ON Semiconductor®

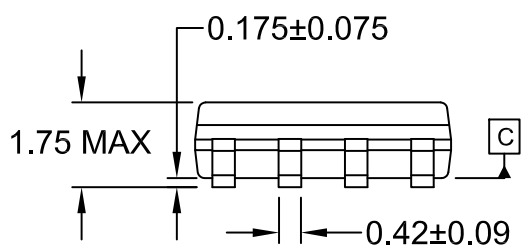
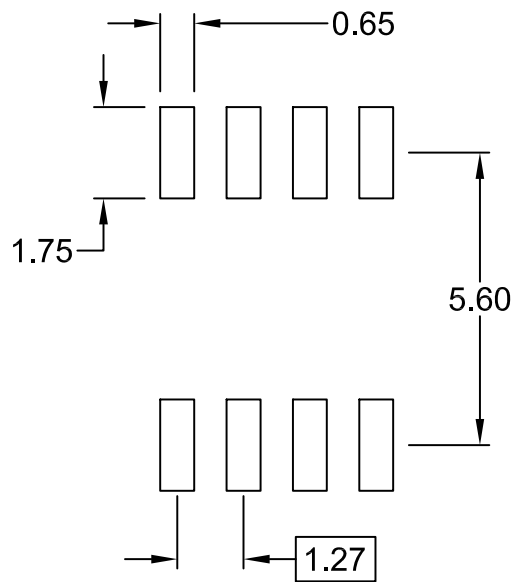


**SOIC8**  
CASE 751EB  
ISSUE A

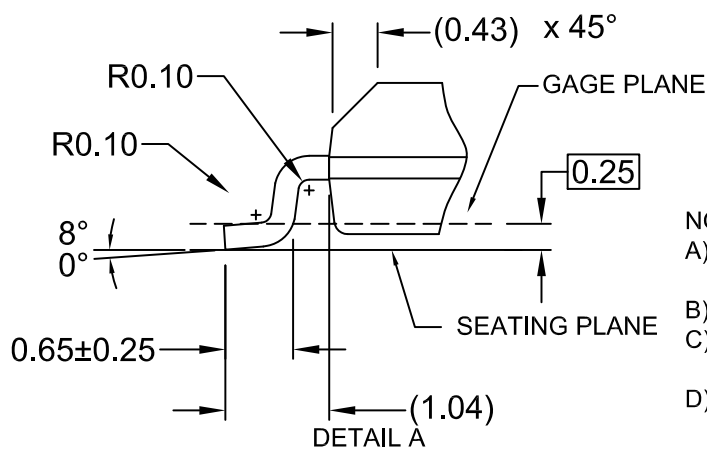
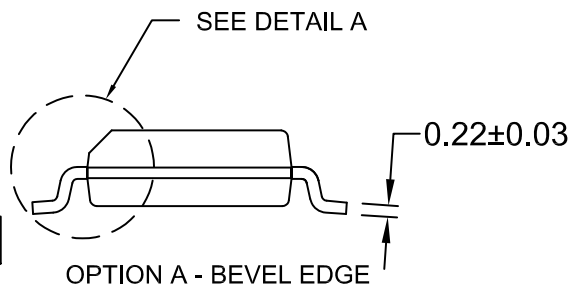
DATE 24 AUG 2017



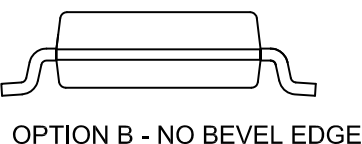
⌀ 0.25 (M) C B A



0.10



DETAIL A  
SCALE: 2:1



### NOTES:

- A) THIS PACKAGE CONFORMS TO JEDEC MS-012, VARIATION AA.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS DO NOT INCLUDE MOLD FLASH OR BURRS.
- D) LANDPATTERN STANDARD: SOIC127P600X175-8M

|                  |             |                                                                                                                                                                                  |
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