



ON Semiconductor®

## FDS8958B

### Dual N & P-Channel PowerTrench® MOSFET

Q1-N-Channel: 30 V, 6.4 A, 26 mΩ Q2-P-Channel: -30 V, -4.5 A, 51 mΩ

#### Features

Q1: N-Channel

- Max  $r_{DS(on)}$  = 26 mΩ at  $V_{GS} = 10$  V,  $I_D = 6.4$  A
- Max  $r_{DS(on)}$  = 39 mΩ at  $V_{GS} = 4.5$  V,  $I_D = 5.2$  A

Q2: P-Channel

- Max  $r_{DS(on)}$  = 51 mΩ at  $V_{GS} = -10$  V,  $I_D = -4.5$  A
- Max  $r_{DS(on)}$  = 80 mΩ at  $V_{GS} = -4.5$  V,  $I_D = -3.3$  A
- HBM ESD protection level > 3.5 kV (Note 3)
- RoHS Compliant

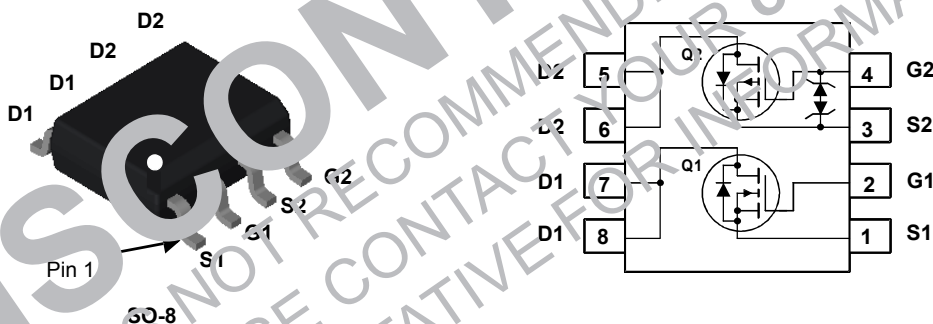
#### General Description

These dual N- and P-Channel enhancement mode power field effect transistors are produced using ON Semiconductor's advanced PowerTrench® process that has been especially tailored to minimize on-state resistance and yet maintain superior switching performance.

These devices are well suited for low voltage and battery powered applications where low line power loss and fast switching are required.

#### Applications

- DC-DC Conversion
- Battery and motor drive inverter



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

| Symbol          | Parameter                  | Q1  | Q2  | Units |
|-----------------|----------------------------|-----|-----|-------|
| V <sub>DS</sub> | Drain to Source Voltage    | 30  | -30 | V     |
| V <sub>GS</sub> | Gate to Source Voltage     | ±20 | ±25 | V     |
| I <sub>D</sub>  | Drain Current - Continuous |     |     |       |

#### Thermal Characteristics

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

#### Package Marking and Ordering Information

| Device Marking | Device   | Package | Reel Size | Tape Width | Quantity   |
|----------------|----------|---------|-----------|------------|------------|
| FDS8958B       | FDS8958B | SO-8    | 13"       | 12 mm      | 2500 units |

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

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

**Off Characteristics**

|                                      |                                           |                                                                                                                                                             |          |           |           |                       |                        |
|--------------------------------------|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------|-----------|-----------------------|------------------------|
| $BV_{DSS}$                           | Drain to Source Breakdown Voltage         | $I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0\text{ V}$<br>$I_D = -250\text{ }\mu\text{A}$ , $V_{GS} = 0\text{ V}$                                           | Q1<br>Q2 | 30<br>-30 |           |                       | V                      |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , referenced to $25\text{ }^{\circ}\text{C}$<br>$I_D = -250\text{ }\mu\text{A}$ , referenced to $25\text{ }^{\circ}\text{C}$ | Q1<br>Q2 |           | 24<br>-21 |                       | mV/ $^{\circ}\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = 24\text{ V}$ , $V_{GS} = 0\text{ V}$<br>$V_{DS} = -24\text{ V}$ , $V_{GS} = 0\text{ V}$                                                           | Q1<br>Q2 |           |           | 1<br>-1               | $\mu\text{A}$          |
| $I_{GSS}$                            | Gate to Source Leakage Current            | $V_{GS} = \pm 20\text{ V}$ , $V_{DS} = 0\text{ V}$<br>$V_{GS} = \pm 25\text{ V}$ , $V_{DS} = 0\text{ V}$                                                    | Q1<br>Q2 |           |           | $\pm 100$<br>$\pm 10$ | nA<br>$\mu\text{A}$    |

**On Characteristics**

|                                        |                                                          |                                                                                                                                                                                                                                                                                                                                                                                       |          |             |                                  |                                  |                        |
|----------------------------------------|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|----------------------------------|----------------------------------|------------------------|
| $V_{GS(th)}$                           | Gate to Source Threshold Voltage                         | $V_{GS} = V_{DS}$ , $I_D = 250\text{ }\mu\text{A}$<br>$V_{GS} = V_{DS}$ , $I_D = -250\text{ }\mu\text{A}$                                                                                                                                                                                                                                                                             | Q1<br>Q2 | 1.0<br>-1.0 | 2.0<br>1.9                       | 3.0<br>-3.0                      | V                      |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate to Source Threshold Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , referenced to $25\text{ }^{\circ}\text{C}$<br>$I_D = -250\text{ }\mu\text{A}$ , referenced to $25\text{ }^{\circ}\text{C}$                                                                                                                                                                                                                           | Q1<br>Q2 |             | 5                                |                                  | mV/ $^{\circ}\text{C}$ |
| $r_{DS(on)}$                           | Static Drain to Source On Resistance                     | $V_{GS} = 10\text{ V}$ , $I_D = 6.4\text{ A}$<br>$V_{GS} = 4.5\text{ V}$ , $I_D = 5.2\text{ A}$<br>$V_{GS} = 10\text{ V}$ , $I_D = 6.4\text{ A}$ , $T_J = 25\text{ }^{\circ}\text{C}$<br>$V_{GS} = -10\text{ V}$ , $I_S = -6.4\text{ A}$<br>$V_{GS} = -4.5\text{ V}$ , $I_S = -5.2\text{ A}$<br>$V_{GS} = -10\text{ V}$ , $I_D = -6.4\text{ A}$ , $T_J = 125\text{ }^{\circ}\text{C}$ | Q1<br>Q2 |             | 21<br>29<br>31<br>38<br>60<br>53 | 26<br>39<br>39<br>51<br>80<br>72 | m $\Omega$             |
| $g_{FS}$                               | Forward Transconductance                                 | $V_{DS} = 5\text{ V}$ , $I_D = 6.4\text{ A}$<br>$V_{DS} = -5\text{ V}$ , $I_S = -4.5\text{ A}$                                                                                                                                                                                                                                                                                        | Q1<br>Q2 |             | 20<br>10                         |                                  | S                      |

**Dynamic Characteristics**

|           |                              |                                                                      |          |  |            |            |          |
|-----------|------------------------------|----------------------------------------------------------------------|----------|--|------------|------------|----------|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 15\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$  | Q1<br>Q2 |  | 405<br>570 | 540<br>760 | pF       |
| $C_{oss}$ | Output Capacitance           |                                                                      | Q1<br>Q2 |  | 75<br>115  | 100<br>155 | pF       |
| $C_{rss}$ | Reverse Transfer Capacitance | $V_{DS} = -15\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$ | Q1<br>Q2 |  | 55<br>100  | 80<br>150  | pF       |
| $R_g$     | Gate Resistance              |                                                                      | Q1<br>Q2 |  | 2.4<br>4.4 |            | $\Omega$ |

**Switching Characteristics**

|              |                               |                                                                                                                  |          |  |            |            |    |
|--------------|-------------------------------|------------------------------------------------------------------------------------------------------------------|----------|--|------------|------------|----|
| $t_{d(on)}$  | Turn-On Delay Time            | Q1<br>$V_{DD} = 15\text{ V}$ , $I_D = 6.4\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ , $R_{GEN} = 6\text{ }\Omega$    | Q1<br>Q2 |  | 4.3<br>6.0 | 10<br>12   | ns |
| $t_r$        | Rise Time                     |                                                                                                                  | Q1<br>Q2 |  | 2.0<br>6.0 | 10<br>12   | ns |
| $t_{d(off)}$ | Turn-Off Delay Time           | Q2<br>$V_{DD} = -15\text{ V}$ , $I_D = -4.5\text{ A}$ ,<br>$V_{GS} = -10\text{ V}$ , $R_{GEN} = 6\text{ }\Omega$ | Q1<br>Q2 |  | 12<br>17   | 22<br>30   | ns |
| $t_f$        | Fall Time                     |                                                                                                                  | Q1<br>Q2 |  | 2.0<br>7.0 | 10<br>14   | ns |
| $Q_{g(TOT)}$ | Total Gate Charge             | $V_{GS} = 10\text{ V}$<br>$V_{GS} = -10\text{ V}$<br>Q1<br>$V_{DD} = 15\text{ V}$ ,<br>$I_D = 6.4\text{ A}$      | Q1<br>Q2 |  | 8.3<br>14  | 12<br>19   | nC |
| $Q_{g(TOT)}$ | Total Gate Charge             | $V_{GS} = 4.5\text{ V}$<br>$V_{GS} = -4.5\text{ V}$                                                              | Q1<br>Q2 |  | 4.1<br>7.0 | 5.8<br>9.6 | nC |
| $Q_{gs}$     | Gate to Source Charge         | Q2<br>$V_{DD} = -15\text{ V}$ ,<br>$I_D = -4.5\text{ A}$                                                         | Q1<br>Q2 |  | 1.3<br>1.9 |            | nC |
| $Q_{gd}$     | Gate to Drain "Miller" Charge |                                                                                                                  | Q1<br>Q2 |  | 1.7<br>3.6 |            | nC |

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

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

**Drain-Source Diode Characteristics**

|          |                                       |                                                              |    |  |      |      |    |
|----------|---------------------------------------|--------------------------------------------------------------|----|--|------|------|----|
| $V_{SD}$ | Source to Drain Diode Forward Voltage | $V_{GS} = 0\text{ V}, I_S = 1.3\text{ A}$ (Note 2)           | Q1 |  | 0.8  | 1.2  | V  |
|          |                                       | $V_{GS} = 0\text{ V}, I_S = -1.3\text{ A}$ (Note 2)          | Q2 |  | -0.8 | -1.2 |    |
| $t_{rr}$ | Reverse Recovery Time                 | Q1<br>$I_F = 6.4\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$ | Q1 |  | 17   | 30   | ns |
|          |                                       |                                                              | Q2 |  | 20   | 36   |    |
| $Q_{rr}$ | Reverse Recovery Charge               | $I_F = -4.5\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$      | Q1 |  | 6    | 12   | nC |
|          |                                       |                                                              | Q2 |  | 8    | 16   |    |

## NOTES:

1.  $R_{\theta JA}$  is determined with the device mounted on a 1 in<sup>2</sup> pad 2 oz copper pad on a 1.5 x 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)  $78^\circ\text{C}/\text{W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



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

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

3. The diode connected between the gate and source serves only as protection against  $V_{SD}$ . No gate overvoltage rating is implied.

4. UIL condition: Starting  $T_J = 25^\circ\text{C}$ ,  $L = 1\text{ mH}$ ,  $I_{AS} = 6\text{ A}$ ,  $V_{DD} = 27\text{ V}$ ,  $V_{GS} = 0\text{ V}$ . (Q1)  
Starting  $T_J = 25^\circ\text{C}$ ,  $L = 1\text{ mH}$ ,  $I_{AS} = -4\text{ A}$ ,  $V_{DD} = -27\text{ V}$ ,  $V_{GS} = 0\text{ V}$ . (Q2)

# Typical Characteristics (Q1 N-Channel) $T_J = 25^\circ\text{C}$ unless otherwise noted

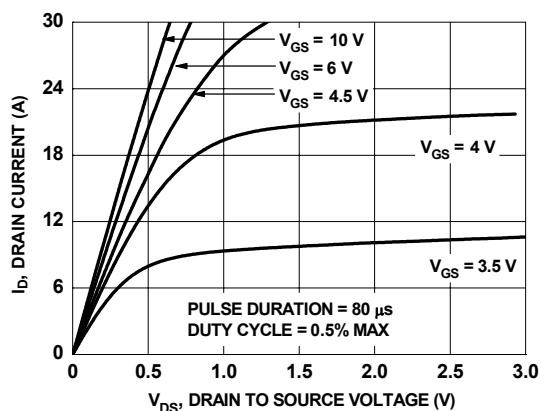


Figure 1. On Region Characteristics

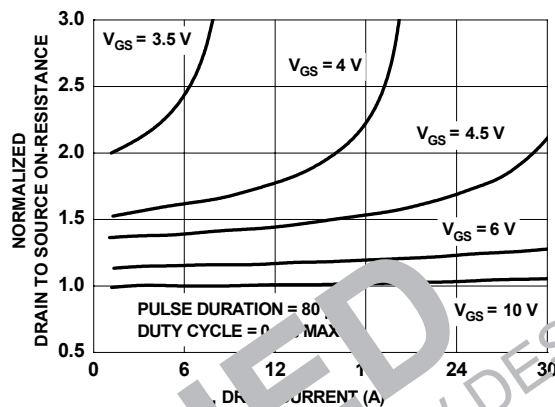


Figure 2. Normalized On-Resistance  
Drain Current and Gate Voltage

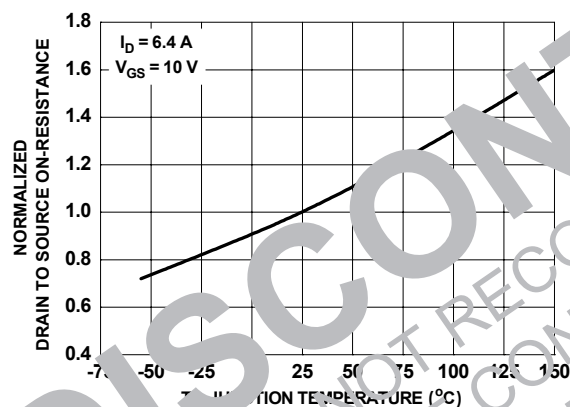


Figure 3. Normalized On-Resistance  
vs Junction Temperature

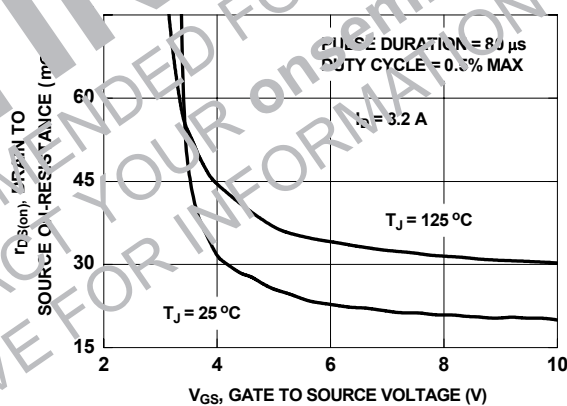


Figure 4. On-Resistance vs Gate to  
Source Voltage

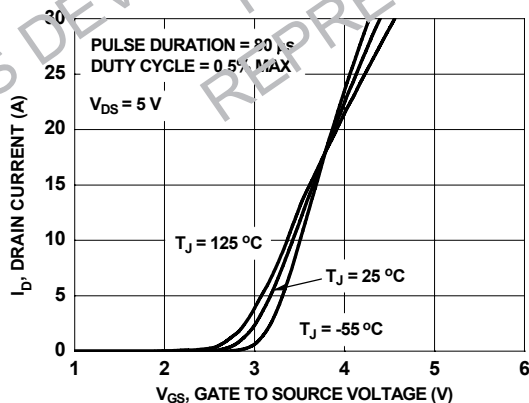


Figure 5. Transfer Characteristics

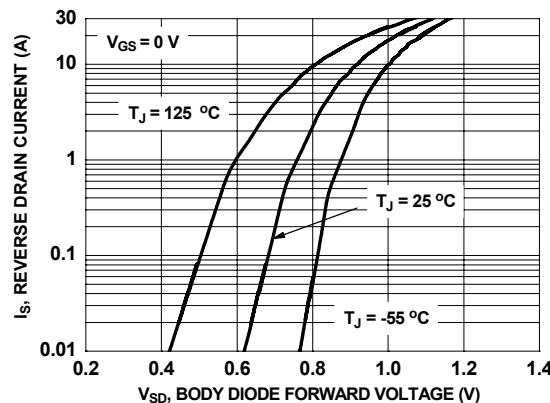


Figure 6. Source to Drain Diode  
Forward Voltage vs Source Current

**Typical Characteristics (Q1 N-Channel)**  $T_J = 25^\circ\text{C}$  unless otherwise noted

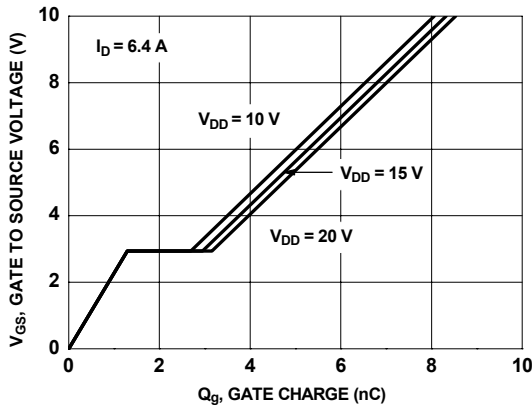


Figure 7. Gate Charge Characteristics

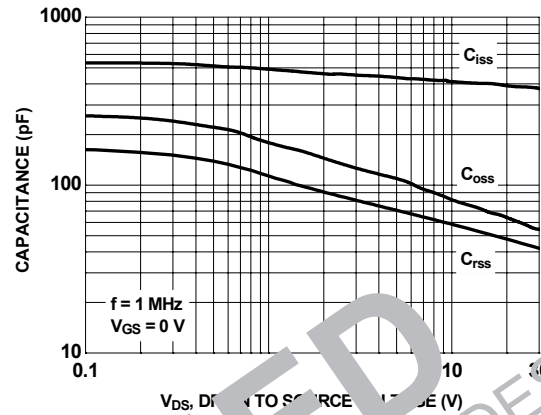


Figure 8. Capacitance vs Drain to Source Voltage

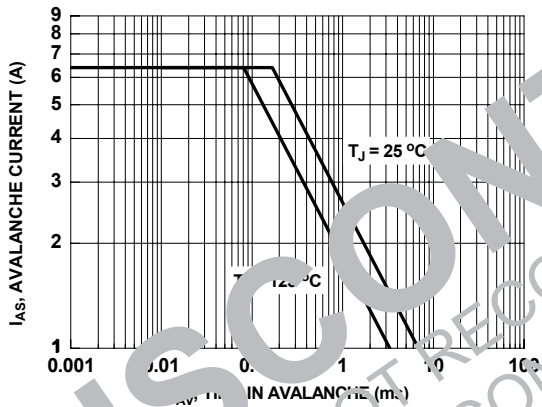


Figure 9. Unclamped Inductive Switching Capability

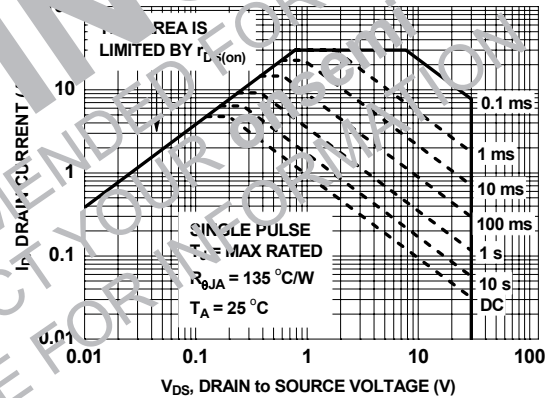


Figure 10. Forward Bias Safe Operating Area

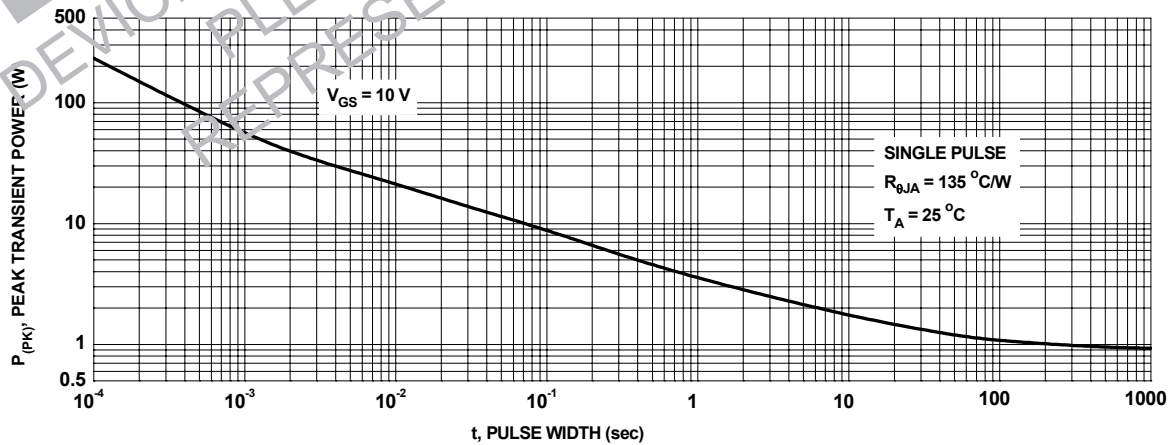


Figure 11. Single Pulse Maximum Power Dissipation

Typical Characteristics (Q1 N-Channel)  $T_J = 25^\circ\text{C}$  unless otherwise noted

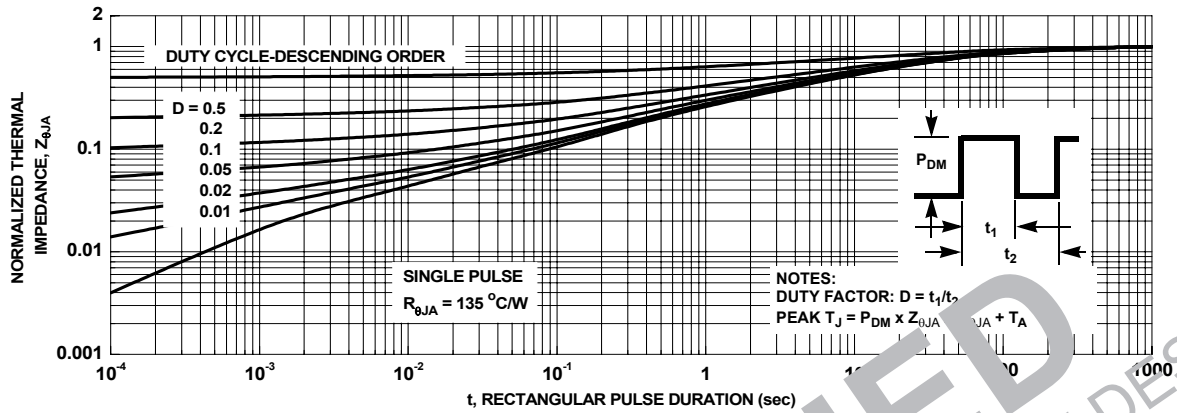


Figure 12. Junction-to-Ambient Transient Thermal Response Curves

# Typical Characteristics (Q2 P-Channel) $T_J = 25^\circ\text{C}$ unless otherwise noted

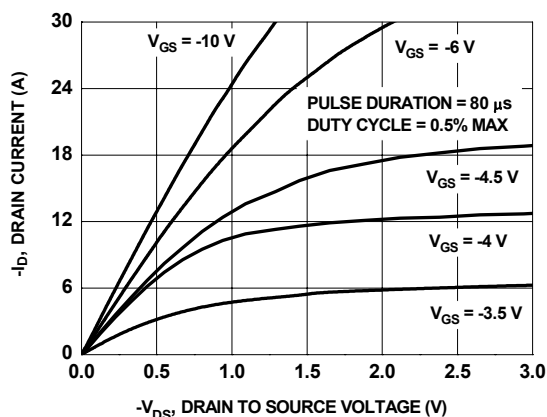


Figure 15. On-Region Characteristics

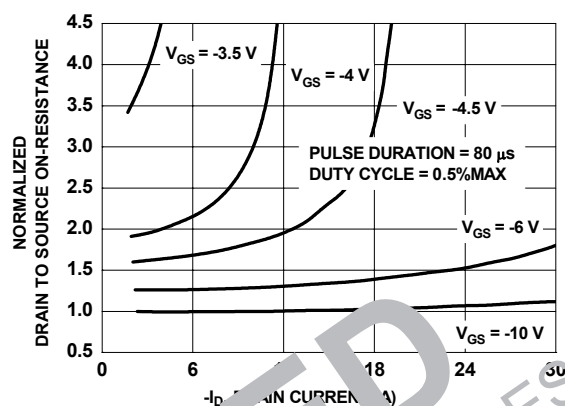


Figure 16. Normalized on-resistance vs Drain Current and Gate Voltage

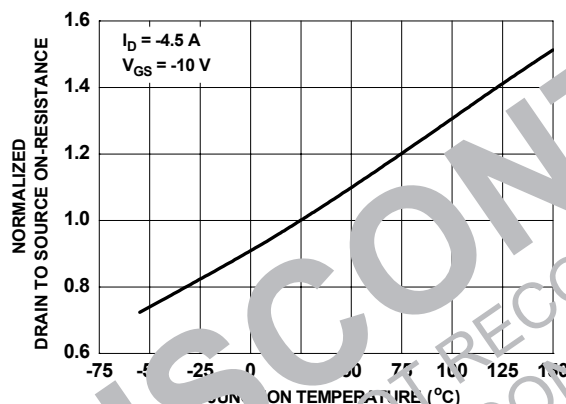


Figure 17. Normalized On-Resistance vs Junction Temperature

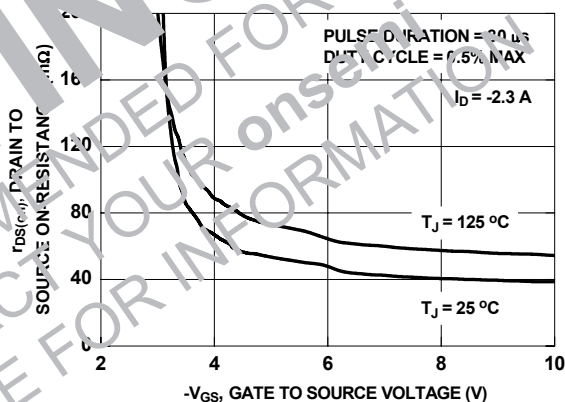


Figure 18. On-Resistance vs Gate to Source Voltage

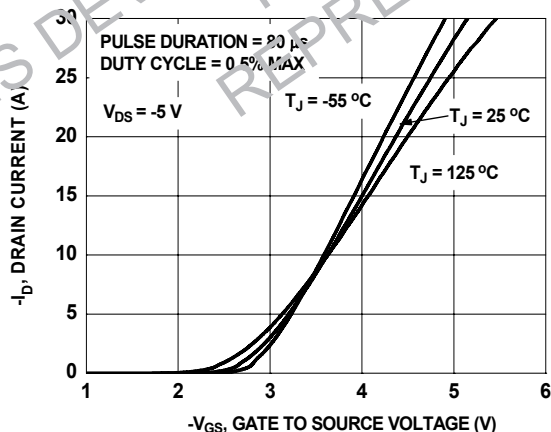


Figure 19. Transfer Characteristics

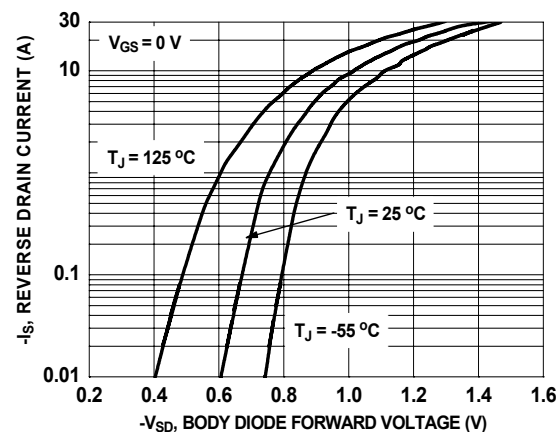


Figure 20. Source to Drain Diode Forward Voltage vs Source Current



# Typical Characteristics (Q2 P-Channel) $T_J = 25^\circ\text{C}$ unless otherwise noted

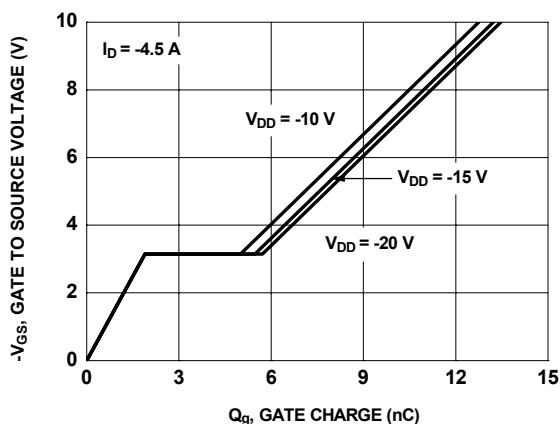


Figure 21. Gate Charge Characteristics

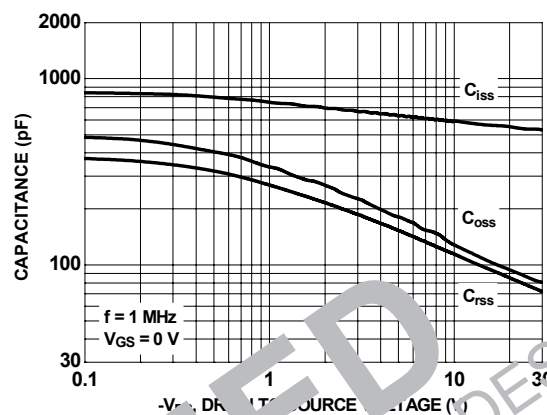


Figure 22. Capacitance vs Drain to Source Voltage

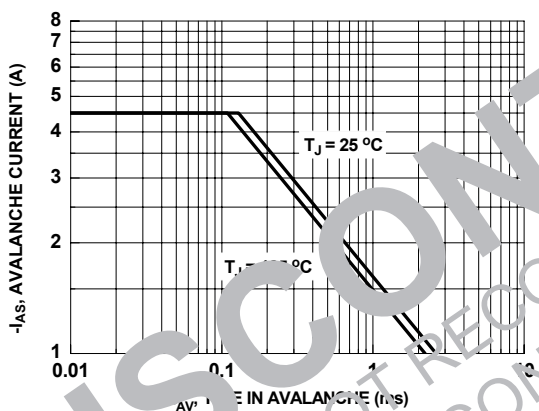


Figure 23. Unclamped Inductive Switching Capability

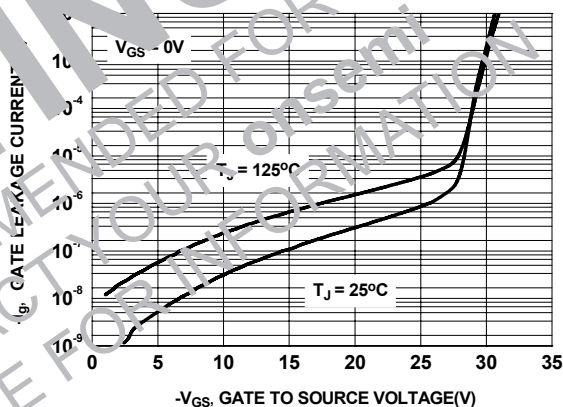


Figure 24.  $I_g$  vs  $V_{gs}$

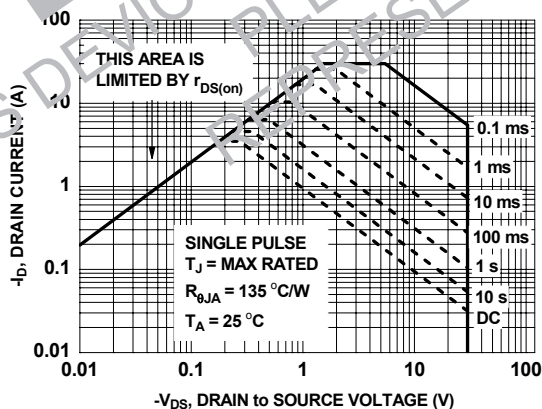


Figure 25. Forward Bias Safe Operating Area

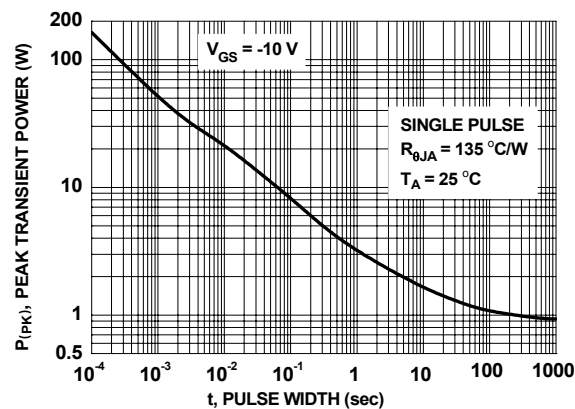


Figure 26. Single Pulse Maximum Power Dissipation



# Typical Characteristics (Q2 P-Channel) $T_J = 25^\circ\text{C}$ unless otherwise noted

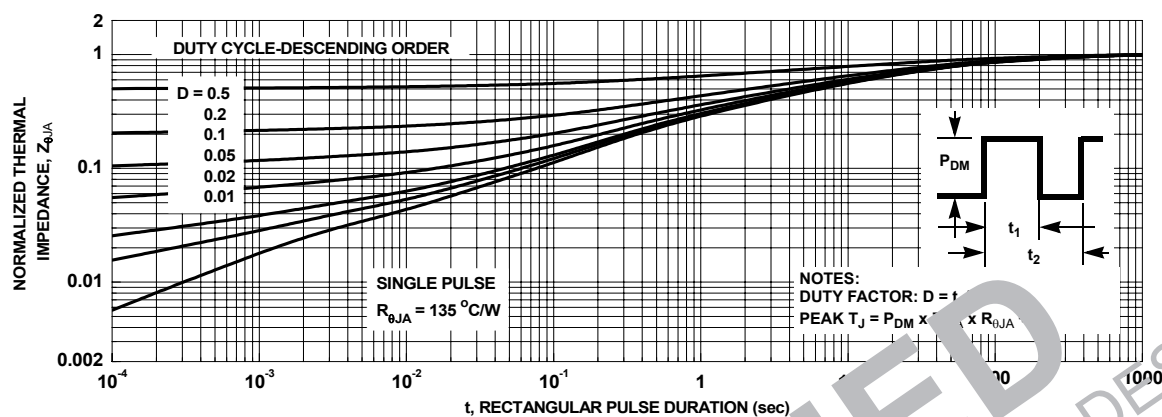


Figure 27. Junction-to-Ambient Transient Thermal Response Curve



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