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# FDD3510H

## Dual N & P-Channel PowerTrench<sup>®</sup> MOSFET

N-Channel: 80V, 13.9A, 80mΩ P-Channel: -80V, -9.4A, 190mΩ

### Features

Q1: N-Channel

- Max  $r_{DS(on)}$  = 80mΩ at  $V_{GS}$  = 10V,  $I_D$  = 4.3A
- Max  $r_{DS(on)}$  = 88mΩ at  $V_{GS}$  = 6V,  $I_D$  = 4.1A

Q2: P-Channel

- Max  $r_{DS(on)}$  = 190mΩ at  $V_{GS}$  = -10V,  $I_D$  = -2.8A
- Max  $r_{DS(on)}$  = 224mΩ at  $V_{GS}$  = -4.5V,  $I_D$  = -2.6A
- 100% UIL Tested
- RoHS Compliant

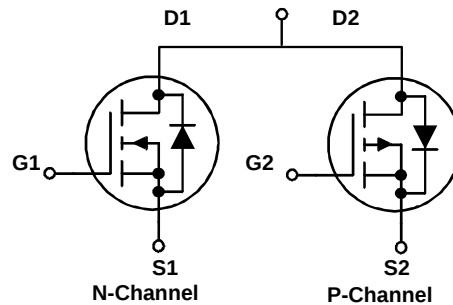
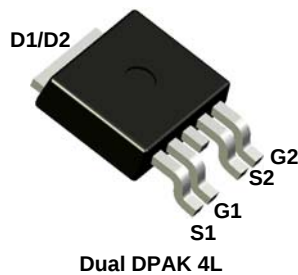


### General Description

These dual N and P-Channel enhancement mode Power MOSFETs are produced using Fairchild Semiconductor's advanced PowerTrench<sup>®</sup> process that has been especially tailored to minimize on-state resistance and yet maintain superior switching performance.

### Applications

- Inverter
- H-Bridge



### 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                          |                                 | 80          | -80  | V     |
| V <sub>GS</sub>                   | Gate to Source Voltage                           |                                 | ±20         | ±20  | V     |
| I <sub>D</sub>                    | Drain Current - Continuous                       | T <sub>C</sub> = 25°C           | 13.9        | -9.4 | A     |
|                                   | - Continuous                                     | T <sub>A</sub> = 25°C           | 4.3         | -2.8 |       |
|                                   | - Pulsed                                         |                                 | 20          | -10  |       |
| P <sub>D</sub>                    | Power Dissipation for Single Operation           | T <sub>C</sub> = 25°C (Note 1)  | 35          | 32   | W     |
|                                   |                                                  | T <sub>A</sub> = 25°C (Note 1a) | 3.1         |      |       |
|                                   |                                                  | T <sub>A</sub> = 25°C (Note 1b) | 1.3         |      |       |
| E <sub>AS</sub>                   | Single Pulse Avalanche Energy (Note 3)           |                                 | 37          | 54   | mJ    |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage Junction Temperature Range |                                 | -55 to +150 |      | °C    |

### Thermal Characteristics

|                 |                                                                        |     |                    |
|-----------------|------------------------------------------------------------------------|-----|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Single Operation for Q1 (Note 1) | 3.5 | $^\circ\text{C/W}$ |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Single Operation for Q2 (Note 1) | 3.9 |                    |

### Package Marking and Ordering Information

| Device Marking | Device   | Package   | Reel Size | Tape Width | Quantity   |
|----------------|----------|-----------|-----------|------------|------------|
| FDD3510H       | FDD3510H | TO-252-4L | 13"       | 16mm       | 2500 units |

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

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

**Off Characteristics**

|                                      |                                           |                                                                                                                         |          |           |           |                        |                  |
|--------------------------------------|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|----------|-----------|-----------|------------------------|------------------|
| $BV_{DSS}$                           | Drain to Source Breakdown Voltage         | $I_D = 250\mu\text{A}$ , $V_{GS} = 0\text{V}$<br>$I_D = -250\mu\text{A}$ , $V_{GS} = 0\text{V}$                         | Q1<br>Q2 | 80<br>-80 |           |                        | V                |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\mu\text{A}$ , referenced to $25^\circ\text{C}$<br>$I_D = -250\mu\text{A}$ , referenced to $25^\circ\text{C}$ | Q1<br>Q2 |           | 84<br>-67 | mV                     | $^\circ\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = 64\text{V}$ , $V_{GS} = 0\text{V}$<br>$V_{DS} = -64\text{V}$ , $V_{GS} = 0\text{V}$                           | Q1<br>Q2 |           |           | 1<br>-1                | $\mu\text{A}$    |
| $I_{GSS}$                            | Gate to Source Leakage Current            | $V_{GS} = \pm 20\text{V}$ , $V_{DS} = 0\text{V}$                                                                        | Q1<br>Q2 |           |           | $\pm 100$<br>$\pm 100$ | nA<br>nA         |

**On Characteristics**

|                                        |                                                          |                                                                                                                                                                              |          |             |                   |                   |                  |
|----------------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|-------------------|-------------------|------------------|
| $V_{GS(th)}$                           | Gate to Source Threshold Voltage                         | $V_{GS} = V_{DS}$ , $I_D = 250\mu\text{A}$<br>$V_{GS} = V_{DS}$ , $I_D = -250\mu\text{A}$                                                                                    | Q1<br>Q2 | 2.0<br>-1.0 | 2.6<br>-1.6       | 4.0<br>-3.0       | V                |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate to Source Threshold Voltage Temperature Coefficient | $I_D = 250\mu\text{A}$ , referenced to $25^\circ\text{C}$<br>$I_D = -250\mu\text{A}$ , referenced to $25^\circ\text{C}$                                                      | Q1<br>Q2 |             | -6.7<br>4.6       | mV                | $^\circ\text{C}$ |
| $r_{DS(on)}$                           | Static Drain to Source On Resistance                     | $V_{GS} = 10\text{V}$ , $I_D = 4.3\text{A}$<br>$V_{GS} = 6.0\text{V}$ , $I_D = 4.1\text{A}$<br>$V_{GS} = 10\text{V}$ , $I_D = 4.3\text{A}$ , $T_J = 125^\circ\text{C}$       | Q1       |             | 64<br>70<br>121   | 80<br>88<br>152   | m $\Omega$       |
|                                        |                                                          | $V_{GS} = -10\text{V}$ , $I_D = -2.8\text{A}$<br>$V_{GS} = -4.5\text{V}$ , $I_D = -2.6\text{A}$<br>$V_{GS} = -10\text{V}$ , $I_D = -2.8\text{A}$ , $T_J = 125^\circ\text{C}$ | Q2       |             | 153<br>184<br>259 | 190<br>224<br>322 |                  |
| $g_{FS}$                               | Forward Transconductance                                 | $V_{DD} = 10\text{V}$ , $I_D = 4.3\text{A}$<br>$V_{DD} = -5\text{V}$ , $I_D = -2.8\text{A}$                                                                                  | Q1<br>Q2 |             | 15<br>6.8         |                   | S                |

**Dynamic Characteristics**

|           |                              |                                                                        |          |  |            |            |          |
|-----------|------------------------------|------------------------------------------------------------------------|----------|--|------------|------------|----------|
| $C_{iss}$ | Input Capacitance            | Q1<br>$V_{DS} = 40\text{V}$ , $V_{GS} = 0\text{V}$ , $f = 1\text{MHz}$ | Q1<br>Q2 |  | 600<br>660 | 800<br>880 | pF       |
| $C_{oss}$ | Output Capacitance           | Q2                                                                     | Q1<br>Q2 |  | 56<br>50   | 75<br>70   | pF       |
| $C_{rss}$ | Reverse Transfer Capacitance | $V_{DS} = -40\text{V}$ , $V_{GS} = 0\text{V}$ , $f = 1\text{MHz}$      | Q1<br>Q2 |  | 27<br>25   | 41<br>40   | pF       |
| $R_g$     | Gate Resistance              | $f = 1\text{MHz}$                                                      | Q1<br>Q2 |  | 1.7<br>7.2 |            | $\Omega$ |

**Switching Characteristics**

|              |                               |                                                                                                       |          |  |            |          |    |
|--------------|-------------------------------|-------------------------------------------------------------------------------------------------------|----------|--|------------|----------|----|
| $t_{d(on)}$  | Turn-On Delay Time            | Q1<br>$V_{DD} = 40\text{V}$ , $I_D = 4.3\text{A}$ ,<br>$V_{GS} = 10\text{V}$ , $R_{GEN} = 6\Omega$    | Q1<br>Q2 |  | 7<br>6     | 13<br>11 | ns |
| $t_r$        | Rise Time                     |                                                                                                       | Q1<br>Q2 |  | 2<br>3     | 10<br>10 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time           | Q2<br>$V_{DD} = -40\text{V}$ , $I_D = -2.8\text{A}$ ,<br>$V_{GS} = -10\text{V}$ , $R_{GEN} = 6\Omega$ | Q1<br>Q2 |  | 16<br>25   | 29<br>40 | ns |
| $t_f$        | Fall Time                     |                                                                                                       | Q1<br>Q2 |  | 2<br>5     | 10<br>10 | ns |
| $Q_{g(TOT)}$ | Total Gate Charge             | Q1<br>$V_{GS} = 10\text{V}$ , $V_{DD} = 40\text{V}$ , $I_D = 4.3\text{A}$                             | Q1<br>Q2 |  | 13<br>14   | 18<br>20 | nC |
| $Q_{gs}$     | Gate to Source Charge         | Q2                                                                                                    | Q1<br>Q2 |  | 2.3<br>1.9 |          | nC |
| $Q_{gd}$     | Gate to Drain "Miller" Charge | $V_{GS} = -10\text{V}$ , $V_{DD} = -40\text{V}$ , $I_D = -2.8\text{A}$                                | Q1<br>Q2 |  | 3.2<br>2.9 |          | 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 | $V_{GS} = 0\text{V}$ , $I_S = 2.6\text{A}$ (Note 2)  | Q1 |  | 0.8  | 1.2  | V  |
|          |                                       | $V_{GS} = 0\text{V}$ , $I_S = -2.6\text{A}$ (Note 2) | Q2 |  | -0.8 | -1.2 |    |
| $t_{rr}$ | Reverse Recovery Time                 | Q1<br>$I_F = 4.3\text{A}$ , $di/dt = 100\text{A/s}$  | Q1 |  | 29   | 46   | ns |
|          |                                       |                                                      | Q2 |  | 30   | 48   |    |
| $Q_{rr}$ | Reverse Recovery Charge               | Q2<br>$I_F = -2.8\text{A}$ , $di/dt = 100\text{A/s}$ | Q1 |  | 28   | 45   | nC |
|          |                                       |                                                      | Q2 |  | 30   | 48   |    |

### Notes:

1.  $R_{\theta JA}$  is determined with the device mounted on a 1in<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.

Q1



a. 40°C/W when mounted on a 1 in<sup>2</sup> pad of 2 oz copper

Scale 1 : 1 on letter size paper



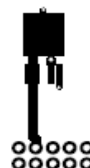
b. 96°C/W when mounted on a minimum pad of 2 oz copper

Q2



a. 40°C/W when mounted on a 1 in<sup>2</sup> pad of 2 oz copper

Scale 1 : 1 on letter size paper



b. 96°C/W when mounted on a minimum pad of 2 oz copper

2. Pulse Test: Pulse Width < 300μs, Duty cycle < 2.0%.

3. Starting  $T_J = 25^{\circ}\text{C}$ , N-ch:  $L = 3\text{mH}$ ,  $I_{AS} = 5\text{A}$ ,  $V_{DD} = 80\text{V}$ ,  $V_{GS} = 10\text{V}$ ; P-ch:  $L = 3\text{mH}$ ,  $I_{AS} = -6\text{A}$ ,  $V_{DD} = -80\text{V}$ ,  $V_{GS} = -10\text{V}$ .

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

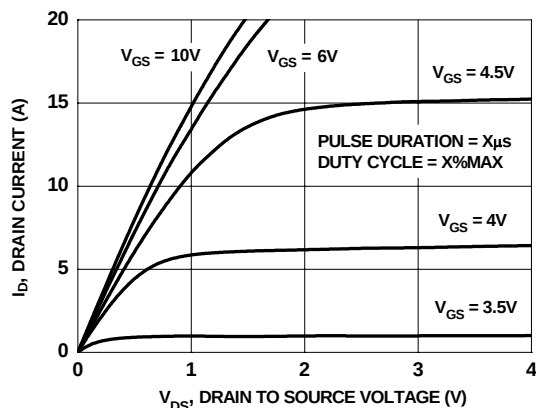


Figure 1. On Region Characteristics

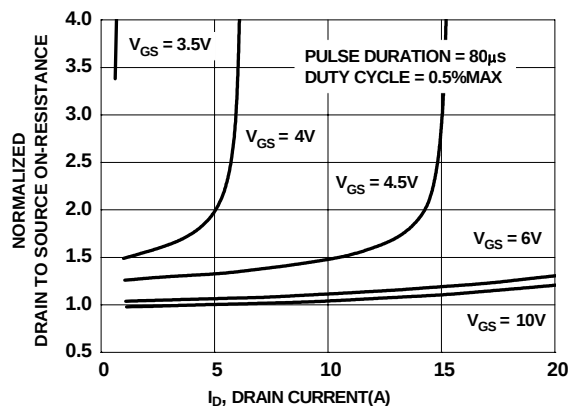


Figure 2. Normalized On-Resistance vs Drain Current and Gate Voltage

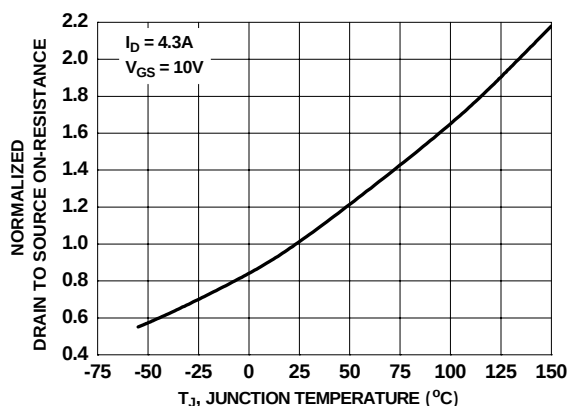


Figure 3. Normalized On Resistance vs Junction Temperature

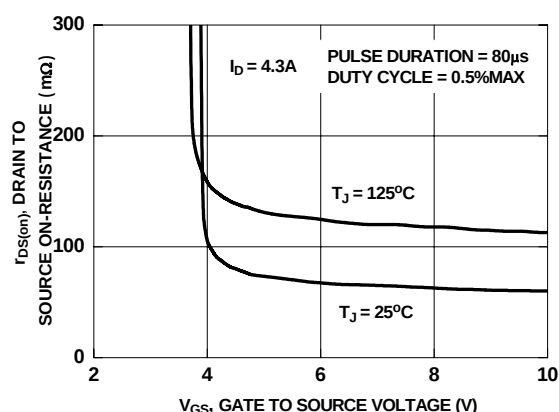


Figure 4. On-Resistance vs Gate to Source Voltage

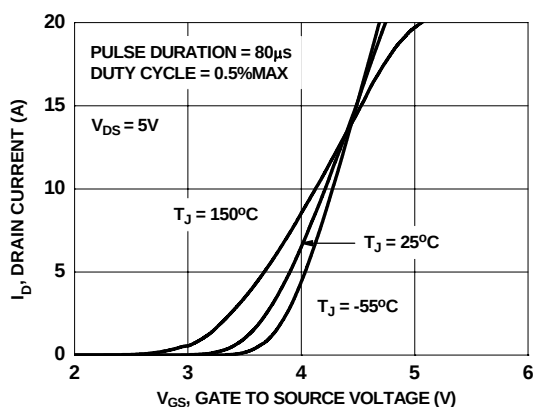


Figure 5. Transfer Characteristics

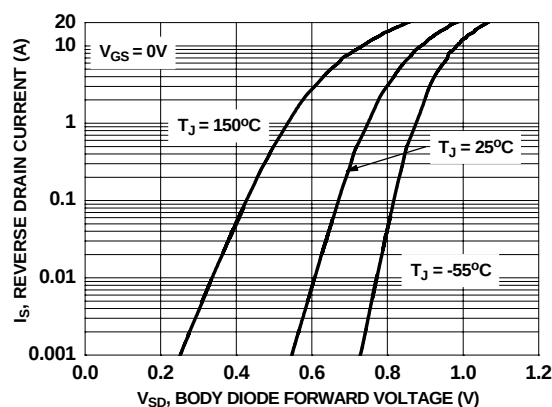


Figure 6. Source to Drain Diode Forward Voltage vs Source Current

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

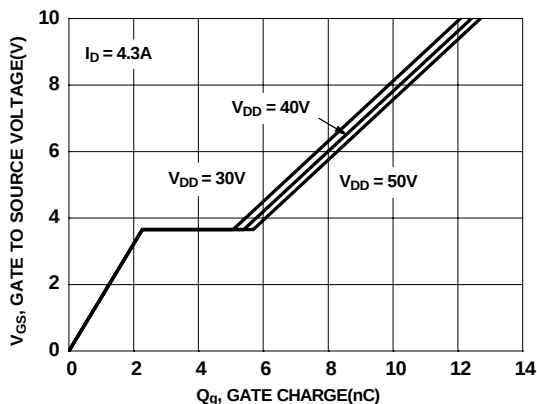


Figure 7. Gate Charge Characteristics

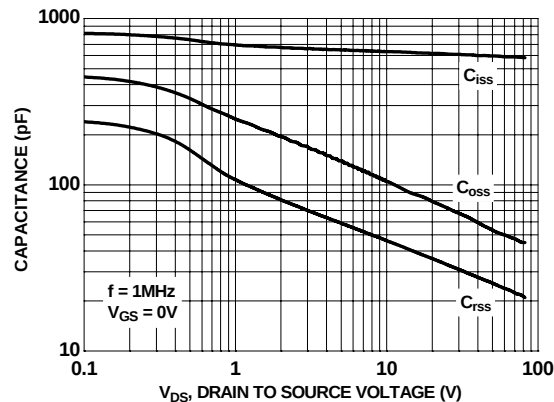


Figure 8. Capacitance vs Drain to Source Voltage

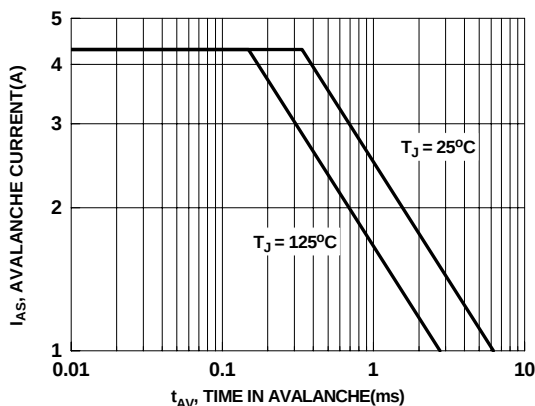


Figure 9. Unclamped Inductive Switching Capability

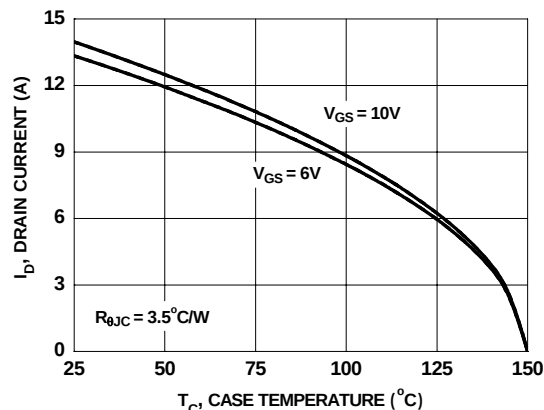


Figure 10. Maximum Continuous Drain Current vs Case Temperature

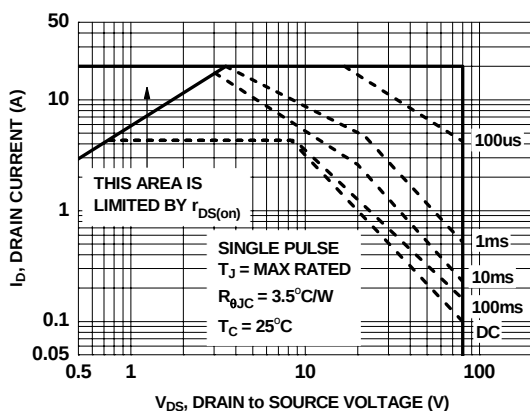


Figure 11. Forward Bias Safe Operating Area

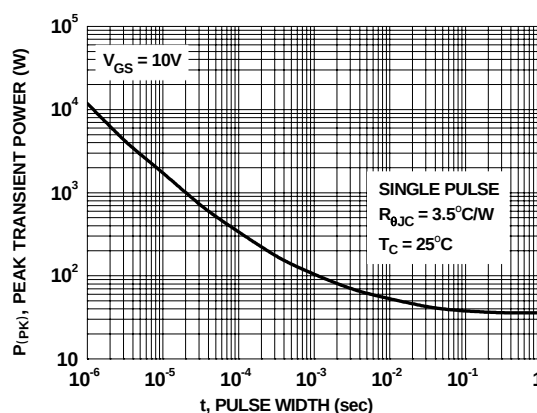


Figure 12. Single Pulse Maximum Power Dissipation

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

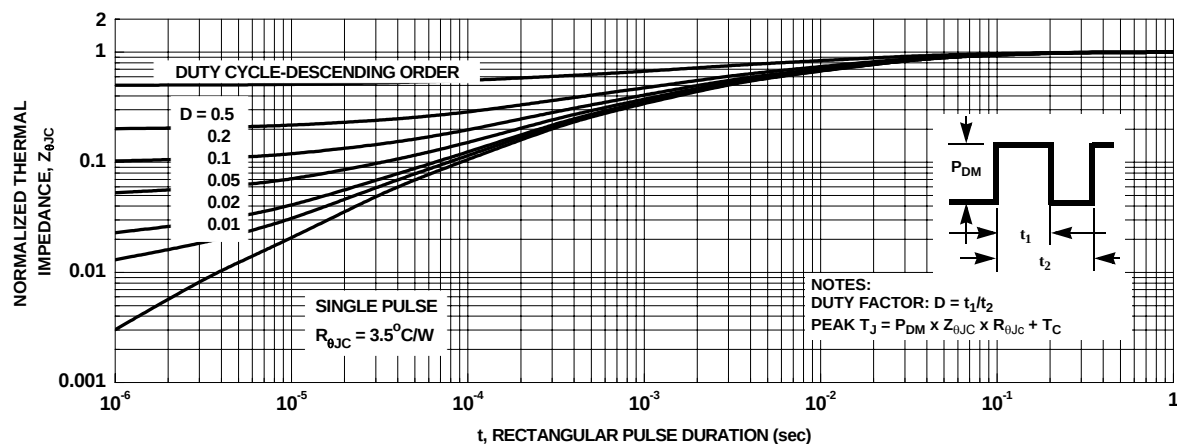


Figure 13. Transient Thermal Response Curve

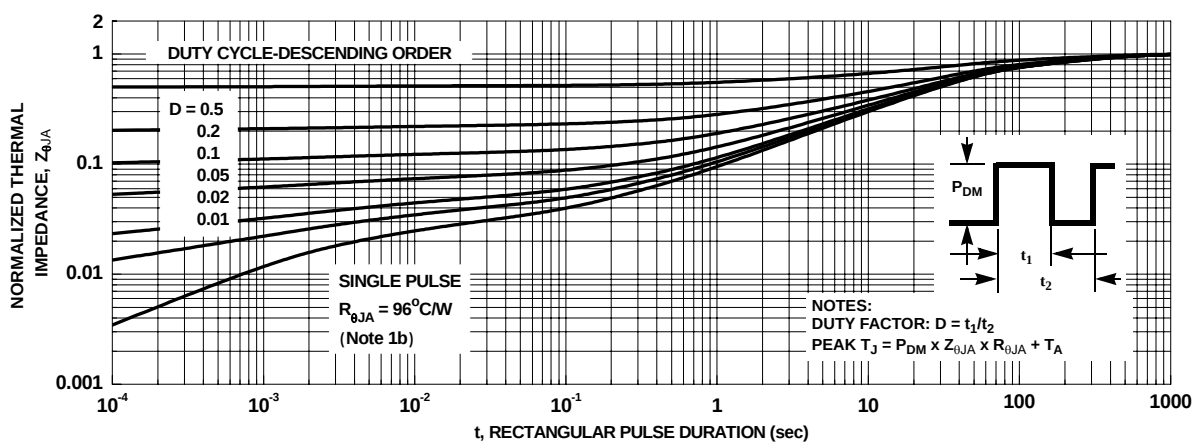


Figure 14. Transient Thermal Response Curve

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

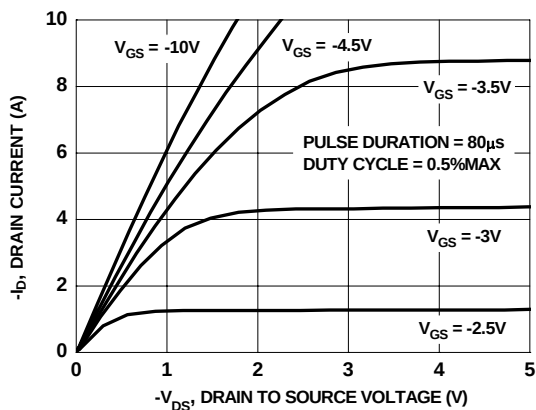


Figure 15. On-Region Characteristics

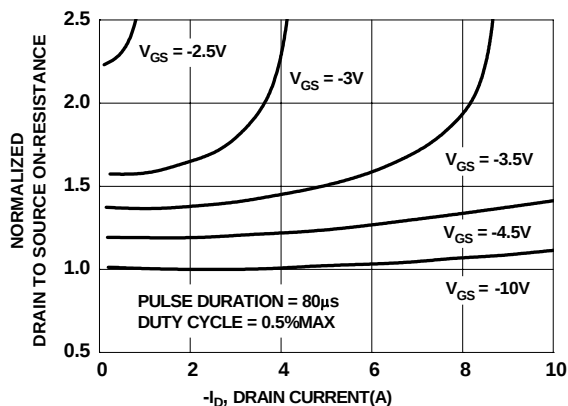


Figure 16. Normalized on-Resistance vs Drain Current and Gate Voltage

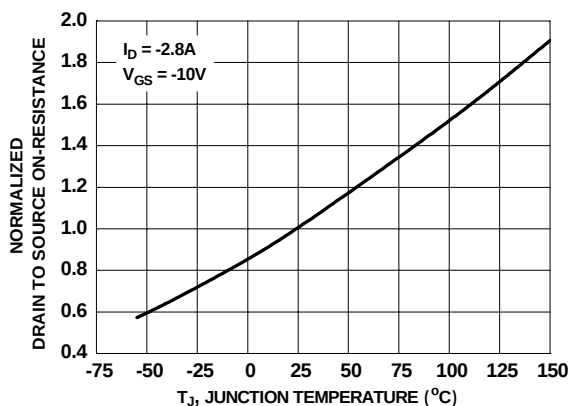


Figure 17. Normalized On-Resistance vs Junction Temperature

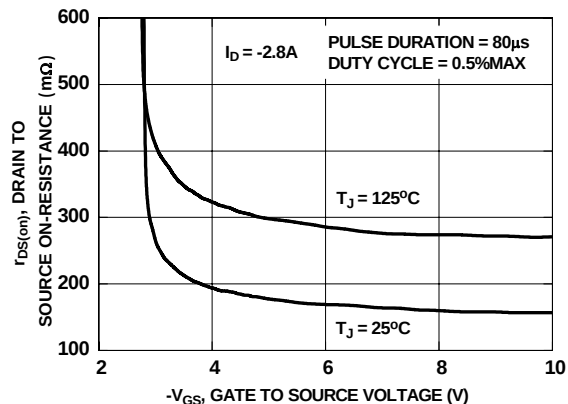


Figure 18. On-Resistance vs Gate to Source Voltage

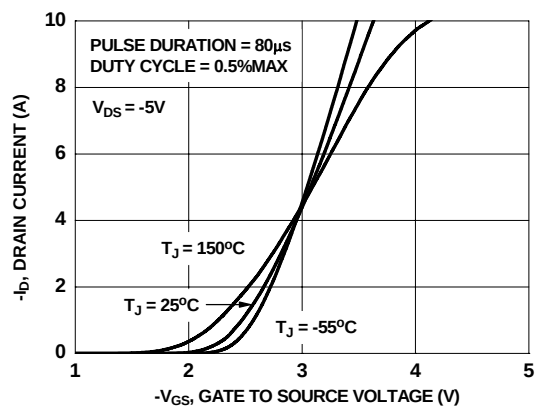


Figure 19. Transfer Characteristics

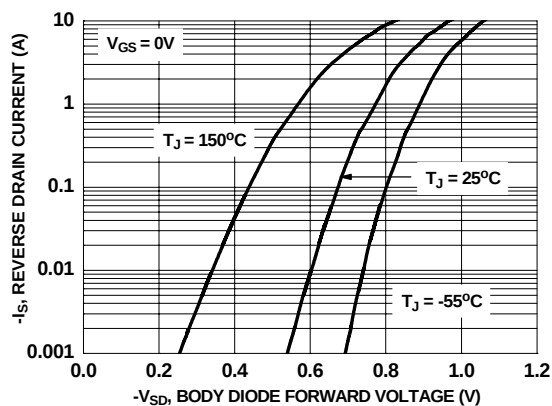


Figure 20. Source to Drain Diode Forward Voltage vs Source Current

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

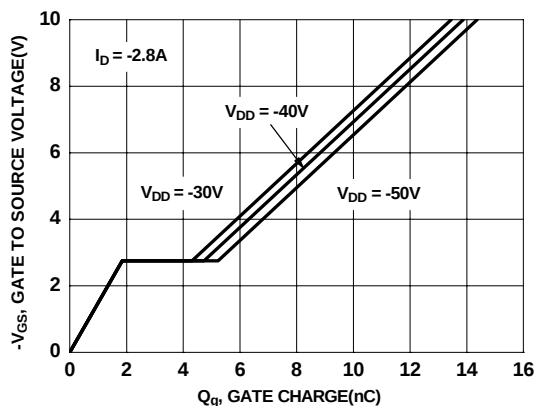


Figure 21. Gate Charge Characteristics

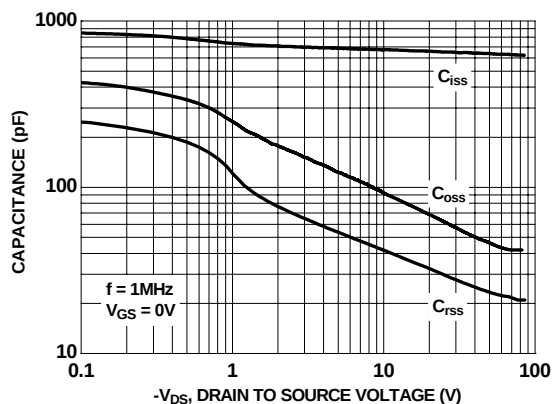


Figure 22. Capacitance vs Drain to Source Voltage

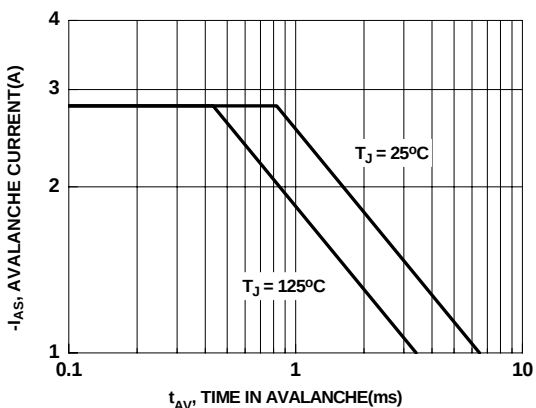


Figure 23. Unclamped Inductive Switching Capability

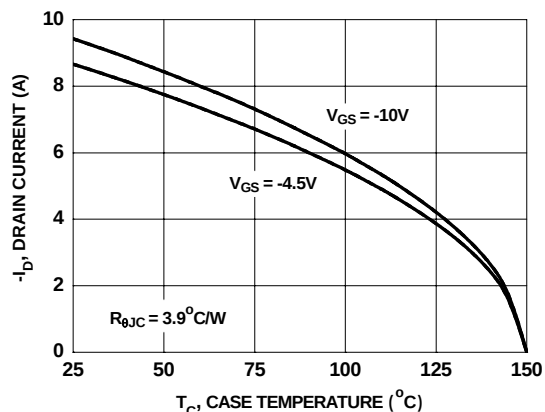


Figure 24. Maximum Continuous Drain Current vs Case Temperature

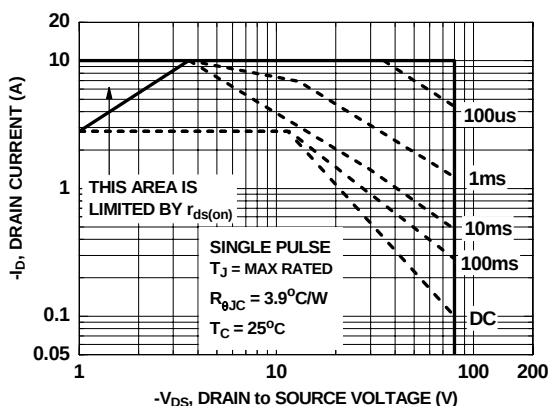


Figure 25. Forward Bias Safe Operating Area

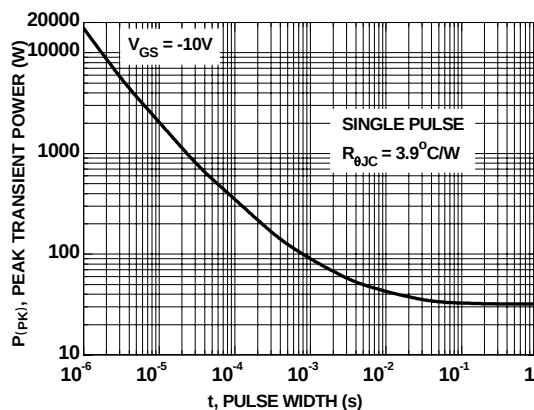
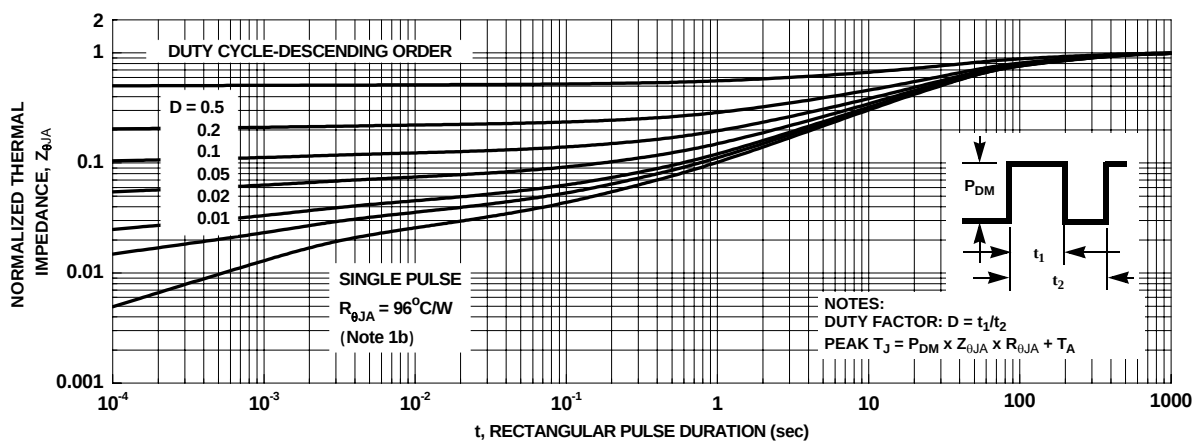
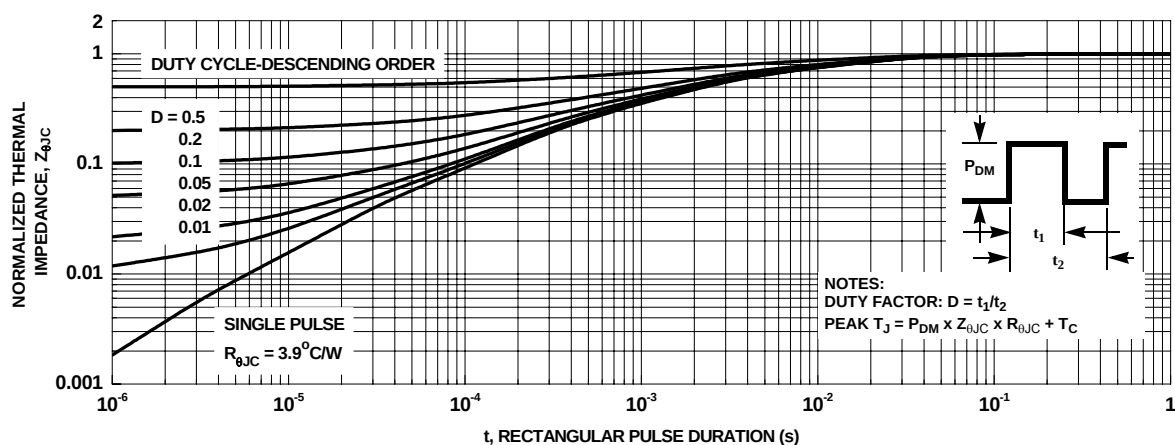
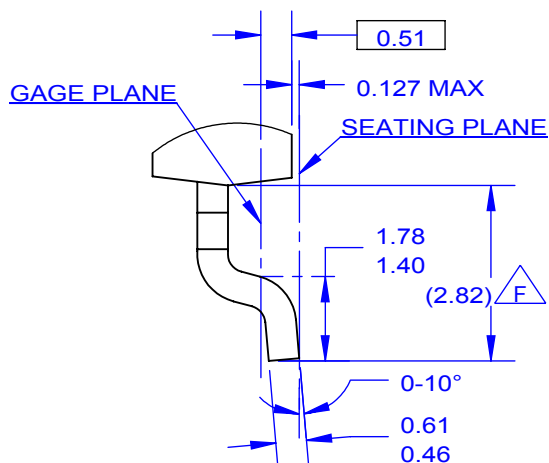
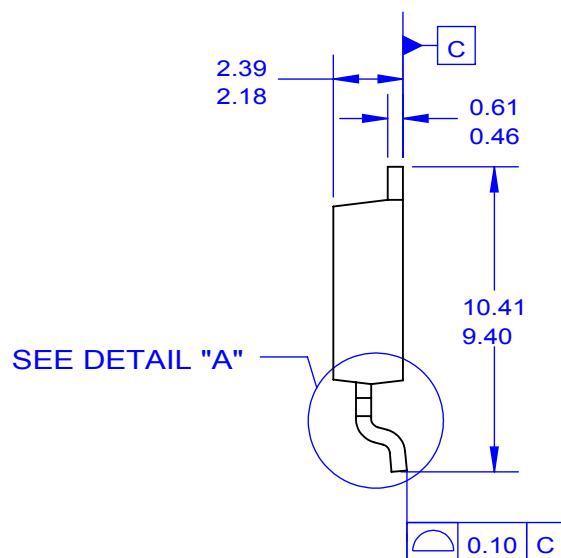
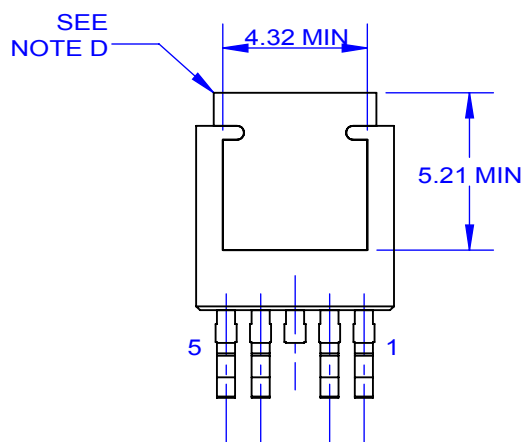
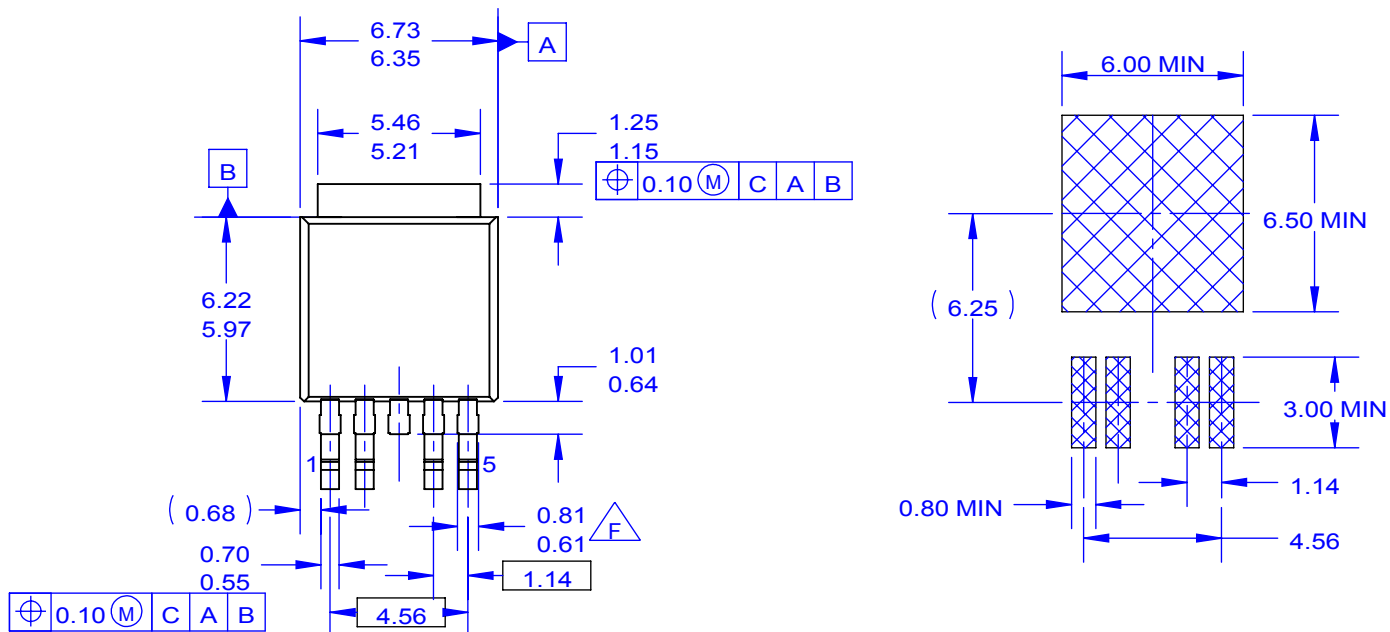


Figure 26. Single Pulse Maximum Power Dissipation

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





DETAIL A  
SCALE 2:1

#### NOTES: UNLESS OTHERWISE SPECIFIED

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