



**ALPHA & OMEGA**  
SEMICONDUCTOR



## AO4441

### P-Channel Enhancement Mode Field Effect Transistor

#### General Description

The AO4441 uses advanced trench technology to provide excellent  $R_{DS(ON)}$ , and ultra-low low gate charge. This device is suitable for use as a load switch or in PWM applications. *Standard Product AO4441 is Pb-free (meets ROHS & Sony 259 specifications). AO4441L is a Green Product ordering option. AO4441 and AO4441L are electrically identical.*

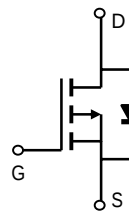
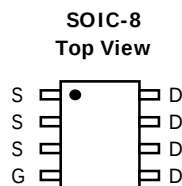
#### Features

$V_{DS}$  (V) = -60V

$I_D$  = -4 A ( $V_{GS}$  = -10V)

$R_{DS(ON)} < 100m\Omega$  ( $V_{GS}$  = -10V)

$R_{DS(ON)} < 130m\Omega$  ( $V_{GS}$  = -4.5V)



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

| Parameter                              | Symbol         | Maximum    | Units            |
|----------------------------------------|----------------|------------|------------------|
| Drain-Source Voltage                   | $V_{DS}$       | -60        | V                |
| Gate-Source Voltage                    | $V_{GS}$       | $\pm 20$   | V                |
| Continuous Drain Current <sup>A</sup>  | $I_D$          | -4         | A                |
| $T_A=25^\circ\text{C}$                 |                | -3.1       |                  |
| $T_A=70^\circ\text{C}$                 |                | -3.1       |                  |
| Pulsed Drain Current <sup>B</sup>      | $I_{DM}$       | -20        |                  |
| Power Dissipation <sup>A</sup>         | $P_D$          | 3.1        | W                |
| $T_A=25^\circ\text{C}$                 |                | 2          |                  |
| $T_A=70^\circ\text{C}$                 |                |            |                  |
| Junction and Storage Temperature Range | $T_J, T_{STG}$ | -55 to 150 | $^\circ\text{C}$ |

#### Thermal Characteristics

| Parameter                                |              | Symbol          | Typ | Max | Units              |
|------------------------------------------|--------------|-----------------|-----|-----|--------------------|
| Maximum Junction-to-Ambient <sup>A</sup> | $t \leq 10s$ | $R_{\theta JA}$ | 24  | 40  | $^\circ\text{C/W}$ |
| Maximum Junction-to-Ambient <sup>A</sup> | Steady-State |                 | 54  | 75  | $^\circ\text{C/W}$ |
| Maximum Junction-to-Lead <sup>C</sup>    | Steady-State | $R_{\theta JL}$ | 21  | 30  | $^\circ\text{C/W}$ |

**P-Channel Electrical Characteristics (T<sub>J</sub>=25°C unless otherwise noted)**

| Symbol                      | Parameter                             | Conditions                                                                                  | Min | Typ       | Max      | Units |
|-----------------------------|---------------------------------------|---------------------------------------------------------------------------------------------|-----|-----------|----------|-------|
| <b>STATIC PARAMETERS</b>    |                                       |                                                                                             |     |           |          |       |
| BV <sub>DSS</sub>           | Drain-Source Breakdown Voltage        | I <sub>D</sub> =-250μA, V <sub>GS</sub> =0V                                                 | -60 |           |          | V     |
| I <sub>DSS</sub>            | Zero Gate Voltage Drain Current       | V <sub>DS</sub> =-48V, V <sub>GS</sub> =0V<br>T <sub>J</sub> =55°C                          |     |           | -1<br>-5 | μA    |
| I <sub>GSS</sub>            | Gate-Body leakage current             | V <sub>DS</sub> =0V, V <sub>GS</sub> =±20V                                                  |     |           | ±100     | nA    |
| V <sub>GS(th)</sub>         | Gate Threshold Voltage                | V <sub>DS</sub> =V <sub>GS</sub> I <sub>D</sub> =-250μA                                     | -1  | -2.1      | -3       | V     |
| I <sub>D(ON)</sub>          | On state drain current                | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-5V                                                 | -20 |           |          | A     |
| R <sub>DS(ON)</sub>         | Static Drain-Source On-Resistance     | V <sub>GS</sub> =-10V, I <sub>D</sub> =-4A<br>T <sub>J</sub> =125°C                         |     | 80<br>130 | 100      | mΩ    |
|                             |                                       | V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-3A                                                 |     | 102       | 130      | mΩ    |
|                             |                                       |                                                                                             |     |           |          |       |
| g <sub>FS</sub>             | Forward Transconductance              | V <sub>DS</sub> =-5V, I <sub>D</sub> =-4A                                                   |     | 10        |          | S     |
| V <sub>SD</sub>             | Diode Forward Voltage                 | I <sub>S</sub> =-1A, V <sub>GS</sub> =0V                                                    |     | -0.77     | -1       | V     |
| I <sub>S</sub>              | Maximum Body-Diode Continuous Current |                                                                                             |     |           | -4       | A     |
| <b>DYNAMIC PARAMETERS</b>   |                                       |                                                                                             |     |           |          |       |
| C <sub>iss</sub>            | Input Capacitance                     | V <sub>GS</sub> =0V, V <sub>DS</sub> =-30V, f=1MHz                                          |     | 930       | 1120     | pF    |
| C <sub>oss</sub>            | Output Capacitance                    |                                                                                             |     | 85        |          | pF    |
| C <sub>rss</sub>            | Reverse Transfer Capacitance          |                                                                                             |     | 35        |          | pF    |
| R <sub>g</sub>              | Gate resistance                       | V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, f=1MHz                                            |     | 7.2       | 9        | Ω     |
| <b>SWITCHING PARAMETERS</b> |                                       |                                                                                             |     |           |          |       |
| Q <sub>g</sub> (10V)        | Total Gate Charge (10V)               | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-30V, I <sub>D</sub> =-4A                           |     | 16        | 20       | nC    |
| Q <sub>g</sub> (4.5V)       | Total Gate Charge (4.5V)              |                                                                                             |     | 8         | 10       | nC    |
| Q <sub>gs</sub>             | Gate Source Charge                    |                                                                                             |     | 2.5       |          | nC    |
| Q <sub>gd</sub>             | Gate Drain Charge                     |                                                                                             |     | 3.2       |          | nC    |
| t <sub>D(on)</sub>          | Turn-On DelayTime                     | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-30V, R <sub>L</sub> =7.5Ω,<br>R <sub>GEN</sub> =3Ω |     | 8         |          | ns    |
| t <sub>r</sub>              | Turn-On Rise Time                     |                                                                                             |     | 3.8       |          | ns    |
| t <sub>D(off)</sub>         | Turn-Off DelayTime                    |                                                                                             |     | 31.5      |          | ns    |
| t <sub>f</sub>              | Turn-Off Fall Time                    |                                                                                             |     | 7.5       |          | ns    |
| t <sub>rr</sub>             | Body Diode Reverse Recovery Time      | I <sub>F</sub> =-4A, dI/dt=100A/μs                                                          |     | 27        | 35       | ns    |
| Q <sub>rr</sub>             | Body Diode Reverse Recovery Charge    | I <sub>F</sub> =-4A, dI/dt=100A/μs                                                          |     | 32        |          | nC    |

A: The value of R<sub>θJA</sub> is measured with the device mounted on 1in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=25°C. The value in any given application depends on the user's specific board design. The current rating is based on the t≤ 10s thermal resistance rating.

B: Repetitive rating, pulse width limited by junction temperature.

C: The R<sub>θJA</sub> is the sum of the thermal impedance from junction to lead R<sub>θJL</sub> and lead to ambient.

D: The static characteristics in Figures 1 to 6,12,14 are obtained using 80μs pulses, duty cycle 0.5% max.

E: These tests are performed with the device mounted on 1 in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=25°C. The SOA curve provides a single pulse rating.

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## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS: P-CHANNEL

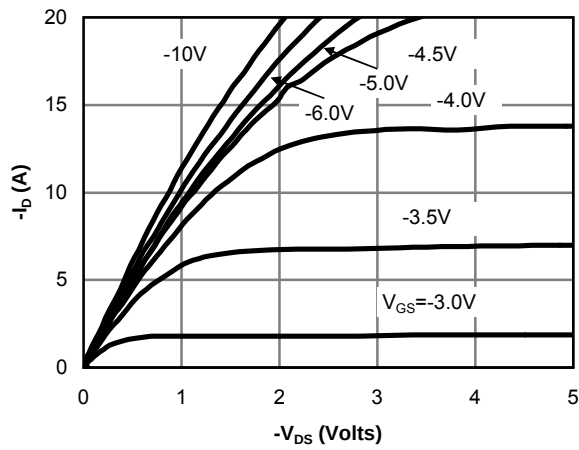


Fig 1: On-Region Characteristics

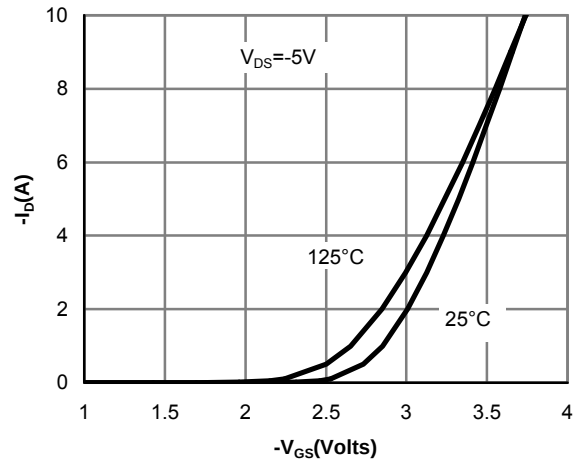


Figure 2: Transfer Characteristics

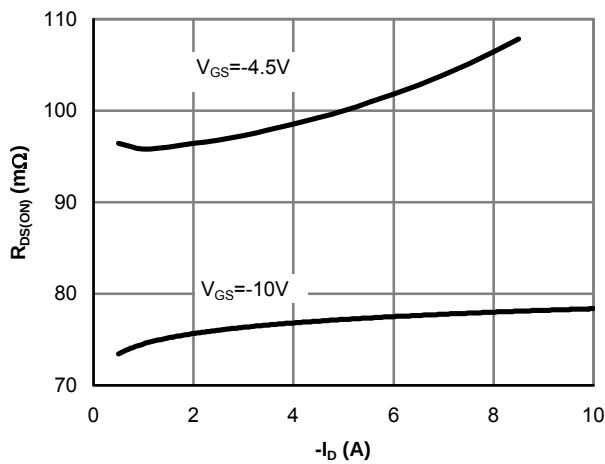


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

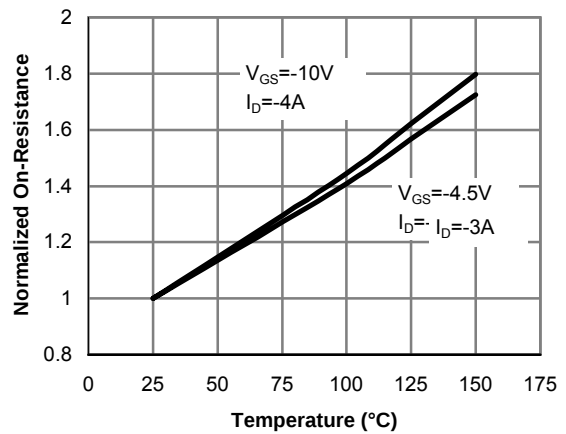


Figure 4: On-Resistance vs. Junction Temperature

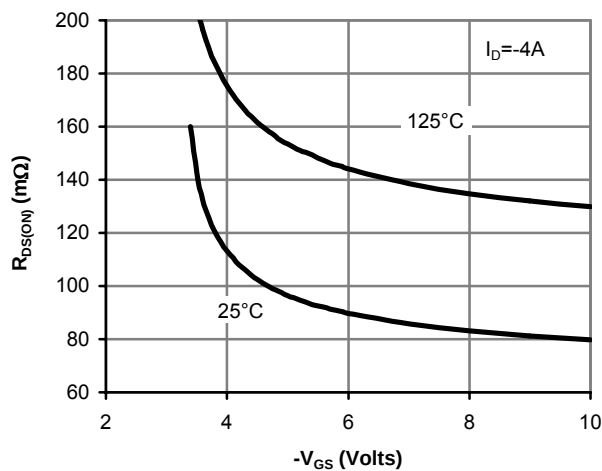


Figure 5: On-Resistance vs. Gate-Source Voltage

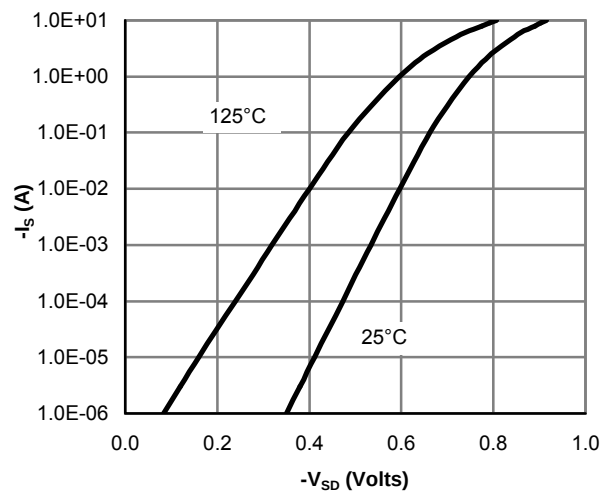


Figure 6: Body-Diode Characteristics

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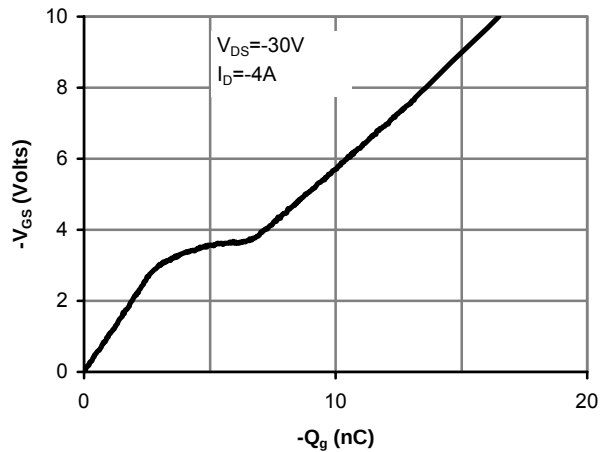


Figure 7: Gate-Charge Characteristics

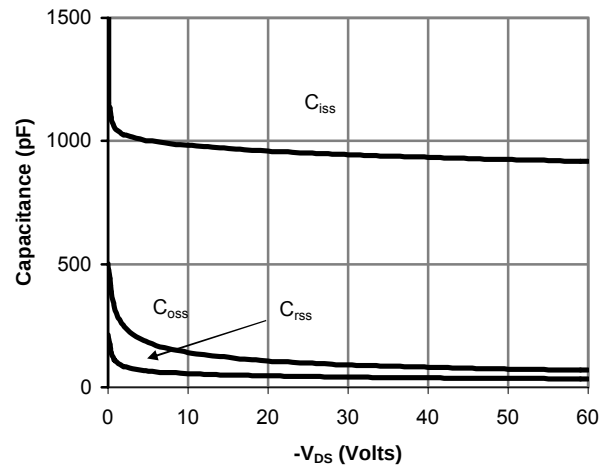


Figure 8: Capacitance Characteristics

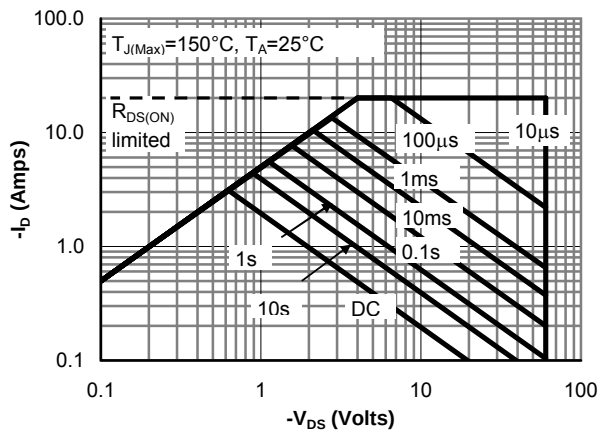


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

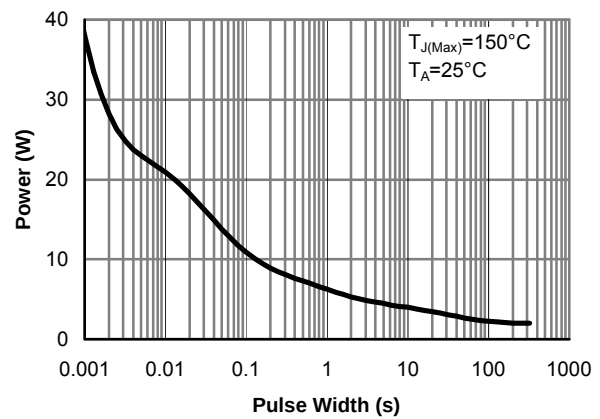


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

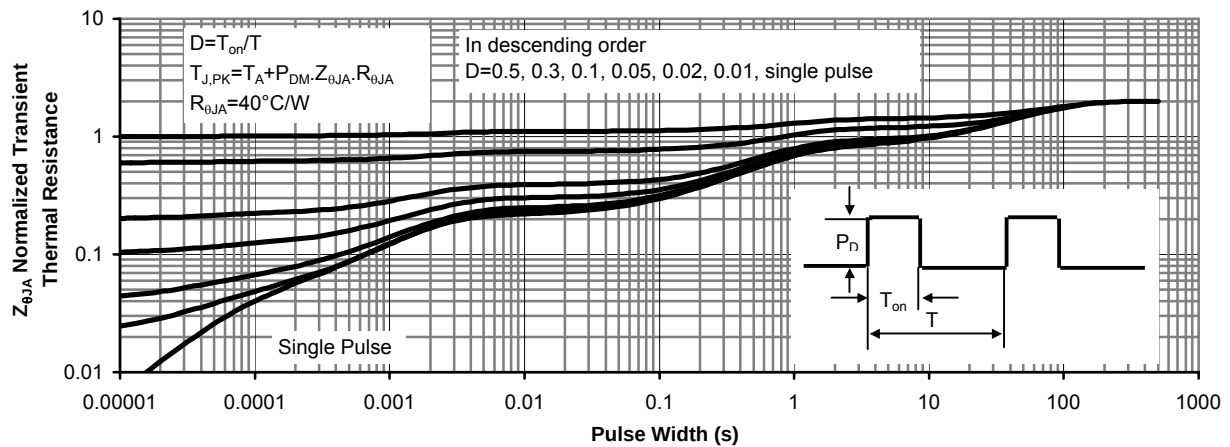


Figure 11: Normalized Maximum Transient Thermal Impedance