



**ALPHA & OMEGA**  
SEMICONDUCTOR, LTD.

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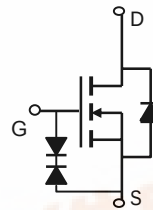
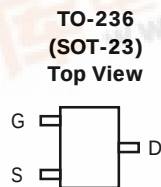
## AO3416, AO3416L ( Green Product ) N-Channel Enhancement Mode Field Effect Transistor

### General Description

The AO3416 uses advanced trench technology to provide excellent  $R_{DS(ON)}$ , low gate charge and operation with gate voltages as low as 1.8V. This device is suitable for use as a load switch or in PWM applications. It is ESD protected. AO3416L ( Green Product ) is offered in a lead-free package.

### Features

$V_{DS}$  (V) = 20V  
 $I_D$  = 6.5 A  
 $R_{DS(ON)} < 22m\Omega$  ( $V_{GS} = 4.5V$ )  
 $R_{DS(ON)} < 26m\Omega$  ( $V_{GS} = 2.5V$ )  
 $R_{DS(ON)} < 34m\Omega$  ( $V_{GS} = 1.8V$ )  
 ESD Rating: 2000V HBM



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

| Parameter                              | Symbol         | Maximum    | Units            |
|----------------------------------------|----------------|------------|------------------|
| Drain-Source Voltage                   | $V_{DS}$       | 20         | V                |
| Gate-Source Voltage                    | $V_{GS}$       | $\pm 8$    | V                |
| Continuous Drain Current <sup>A</sup>  | $I_D$          | 6.5        | A                |
|                                        |                | 5.2        |                  |
| Pulsed Drain Current <sup>B</sup>      | $I_{DM}$       | 30         |                  |
| Power Dissipation <sup>A</sup>         | $P_D$          | 1.4        | W                |
|                                        |                | 0.9        |                  |
| 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> | $R_{\theta JA}$ | 65  | 90  | $^\circ\text{C/W}$ |
| Maximum Junction-to-Ambient <sup>A</sup> |                 | 85  | 125 | $^\circ\text{C/W}$ |
| Maximum Junction-to-Lead <sup>C</sup>    | $R_{\theta JL}$ | 43  | 60  | $^\circ\text{C/W}$ |



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

| Symbol                      | Parameter                             | Conditions                                                                        | Min | Typ      | Max      | Units            |
|-----------------------------|---------------------------------------|-----------------------------------------------------------------------------------|-----|----------|----------|------------------|
| <b>STATIC PARAMETERS</b>    |                                       |                                                                                   |     |          |          |                  |
| $BV_{DSS}$                  | Drain-Source Breakdown Voltage        | $I_D=250\mu\text{A}$ , $V_{GS}=0\text{V}$                                         | 20  |          |          | V                |
| $I_{DSS}$                   | Zero Gate Voltage Drain Current       | $V_{DS}=16\text{V}$ , $V_{GS}=0\text{V}$<br>$T_J=55^{\circ}\text{C}$              |     |          | 1<br>5   | $\mu\text{A}$    |
| $I_{GSS}$                   | Gate-Body leakage current             | $V_{DS}=0\text{V}$ , $V_{GS}=\pm 4.5\text{V}$                                     |     |          | $\pm 1$  | $\mu\text{A}$    |
|                             |                                       | $V_{DS}=0\text{V}$ , $V_{GS}=\pm 8\text{V}$                                       |     |          | $\pm 10$ | $\mu\text{A}$    |
| $V_{GS(th)}$                | Gate Threshold Voltage                | $V_{DS}=V_{GS}$ , $I_D=250\mu\text{A}$                                            | 0.4 | 0.6      | 1        | V                |
| $I_{D(ON)}$                 | On state drain current                | $V_{GS}=4.5\text{V}$ , $V_{DS}=5\text{V}$                                         | 30  |          |          | A                |
| $R_{DS(ON)}$                | Static Drain-Source On-Resistance     | $V_{GS}=4.5\text{V}$ , $I_D=6.5\text{A}$<br>$T_J=125^{\circ}\text{C}$             |     | 18<br>25 | 22<br>30 | $\text{m}\Omega$ |
|                             |                                       | $V_{GS}=2.5\text{V}$ , $I_D=5.5\text{A}$                                          |     | 21       | 26       | $\text{m}\Omega$ |
|                             |                                       | $V_{GS}=1.8\text{V}$ , $I_D=5\text{A}$                                            |     | 26       | 34       | $\text{m}\Omega$ |
| $g_{FS}$                    | Forward Transconductance              | $V_{DS}=5\text{V}$ , $I_D=6.5\text{A}$                                            |     | 29       |          | S                |
| $V_{SD}$                    | Diode Forward Voltage                 | $I_S=1\text{A}$ , $V_{GS}=0\text{V}$                                              |     | 0.76     | 1        | V                |
| $I_S$                       | Maximum Body-Diode Continuous Current |                                                                                   |     |          | 2.5      | A                |
| <b>DYNAMIC PARAMETERS</b>   |                                       |                                                                                   |     |          |          |                  |
| $C_{iss}$                   | Input Capacitance                     | $V_{GS}=0\text{V}$ , $V_{DS}=10\text{V}$ , $f=1\text{MHz}$                        |     | 1160     |          | pF               |
| $C_{oss}$                   | Output Capacitance                    |                                                                                   |     | 187      |          | pF               |
| $C_{rss}$                   | Reverse Transfer Capacitance          |                                                                                   |     | 146      |          | pF               |
| $R_g$                       | Gate resistance                       | $V_{GS}=0\text{V}$ , $V_{DS}=0\text{V}$ , $f=1\text{MHz}$                         |     | 1.5      |          | $\Omega$         |
| <b>SWITCHING PARAMETERS</b> |                                       |                                                                                   |     |          |          |                  |
| $Q_g$                       | Total Gate Charge                     | $V_{GS}=4.5\text{V}$ , $V_{DS}=10\text{V}$ , $I_D=6.5\text{A}$                    |     | 16       |          | nC               |
| $Q_{gs}$                    | Gate Source Charge                    |                                                                                   |     | 0.8      |          | nC               |
| $Q_{gd}$                    | Gate Drain Charge                     |                                                                                   |     | 3.8      |          | nC               |
| $t_{D(on)}$                 | Turn-On DelayTime                     | $V_{GS}=5\text{V}$ , $V_{DS}=10\text{V}$ , $R_L=1.5\Omega$ ,<br>$R_{GEN}=3\Omega$ |     | 6.2      |          | ns               |
| $t_r$                       | Turn-On Rise Time                     |                                                                                   |     | 12.7     |          | ns               |
| $t_{D(off)}$                | Turn-Off DelayTime                    |                                                                                   |     | 51.7     |          | ns               |
| $t_f$                       | Turn-Off Fall Time                    |                                                                                   |     | 16       |          | ns               |
| $t_{rr}$                    | Body Diode Reverse Recovery Time      | $I_F=6.5\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$                               |     | 17.7     |          | ns               |
| $Q_{rr}$                    | Body Diode Reverse Recovery Charge    | $I_F=6.5\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$                               |     | 6.7      |          | nC               |

A: The value of  $R_{\theta JA}$  is measured with the device mounted on 1in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with  $T_A=25^{\circ}\text{C}$ . The value in any a given application depends on the user's specific board design. The current rating is based on the  $t \leq 10\text{s}$  thermal resistance rating.

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

C. The  $R_{\theta JA}$  is the sum of the thermal impedance from junction to lead  $R_{\theta JL}$  and lead to ambient.

D. The static characteristics in Figures 1 to 6,12,14 are obtained using 80 $\mu\text{s}$  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  $T_A=25^{\circ}\text{C}$ . The SOA curve provides a single pulse rating.

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

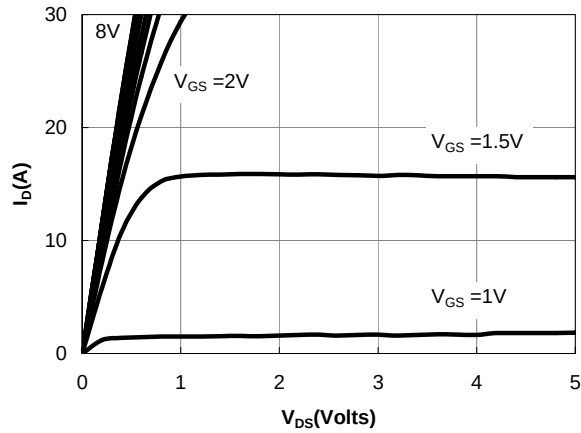


Figure 1: On-Regions Characteristics

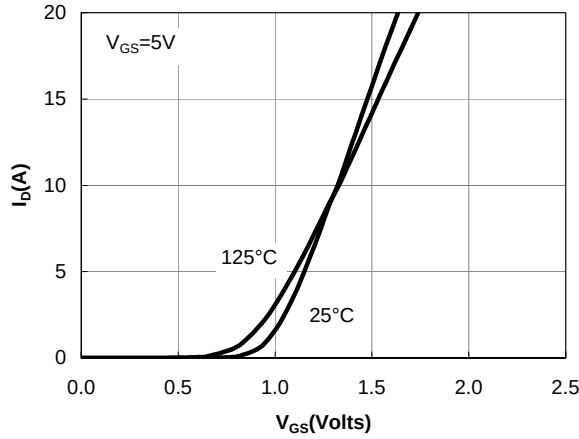


Figure 2: Transfer Characteristics

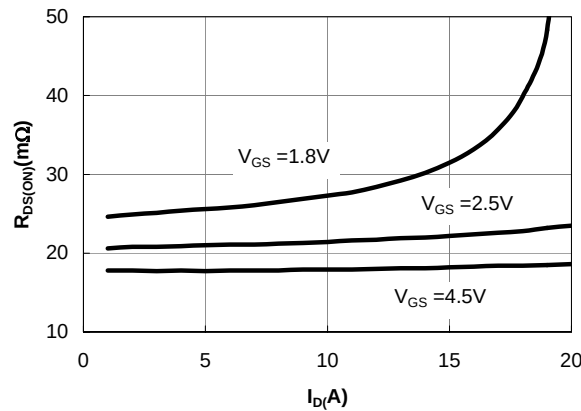


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

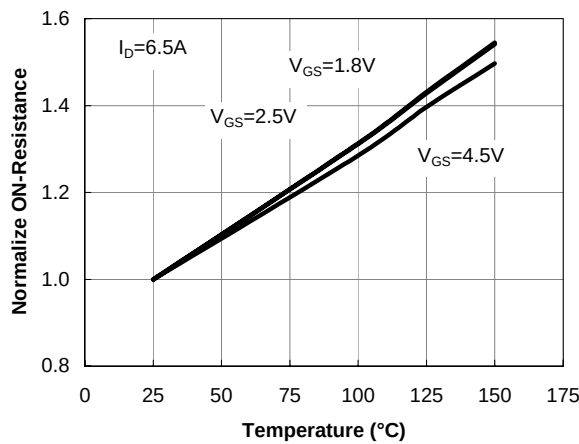


Figure 4: On-Resistance vs. Junction Temperature

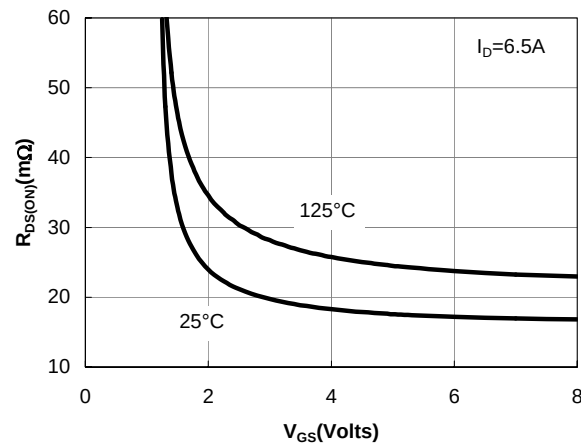


Figure 5: On-Resistance vs. Gate-Source Voltage

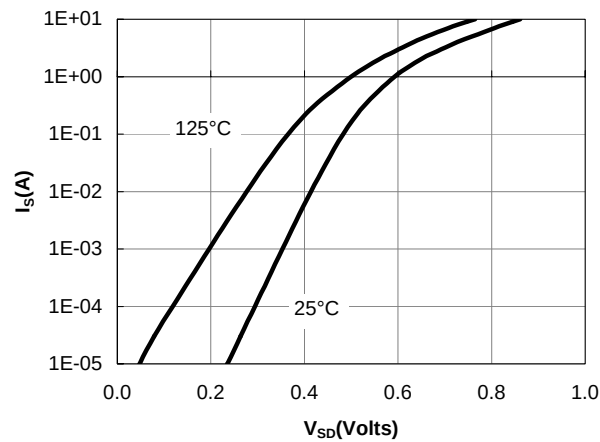


Figure 6: Body-Diode Characteristics

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

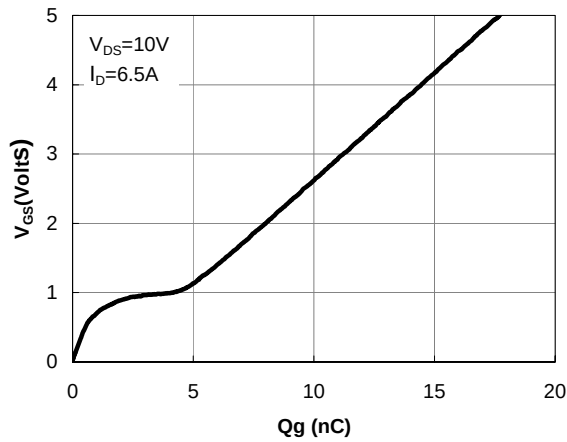


Figure 7: Gate-Charge Characteristics

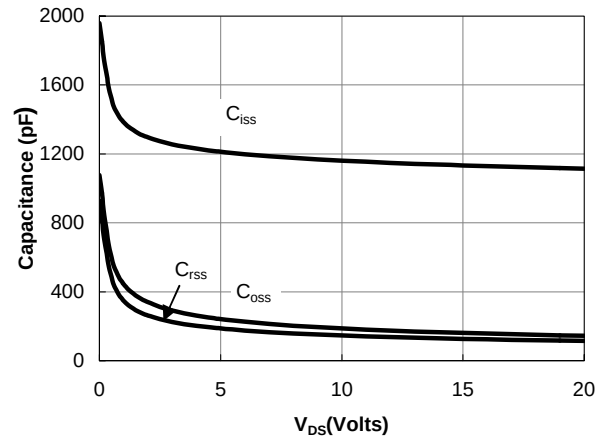


Figure 8: Capacitance Characteristics

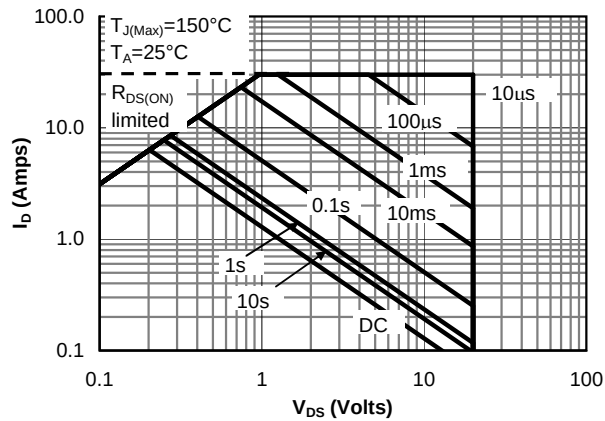


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

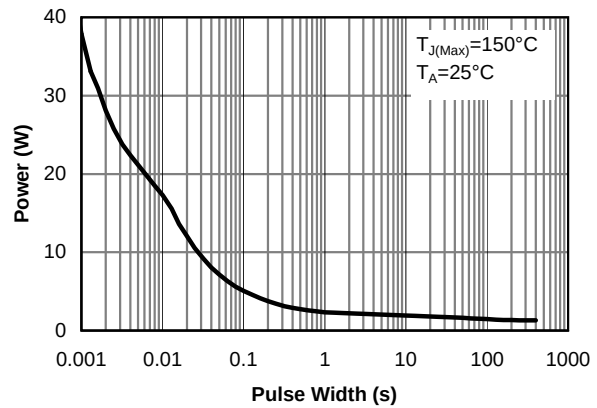


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

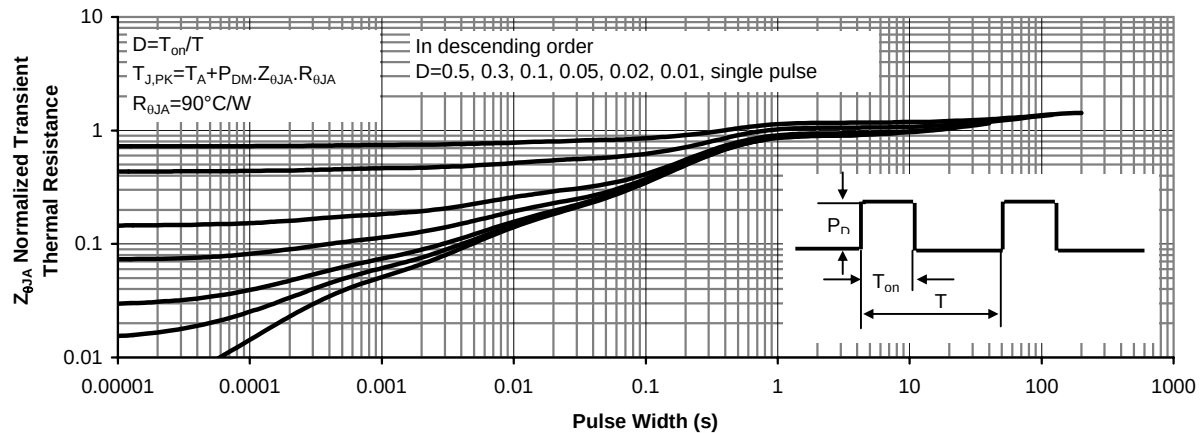


Figure 11: Normalized Maximum Transient Thermal Impedance