



## AO3409

### P-Channel Enhancement Mode Field Effect Transistor

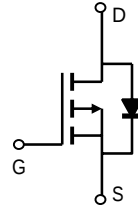
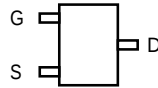
#### General Description

The AO3409 uses advanced trench technology to provide excellent  $R_{DS(ON)}$  and low gate charge. This device is suitable for use as a load switch or in PWM applications. *Standard Product AO3409 is Pb-free (meets ROHS & Sony 259 specifications). AO3409L is a Green Product ordering option. AO3409 and AO3409L are electrically identical.*

#### Features

$V_{DS} (V) = -30V$   
 $I_D = -2.6 A (V_{GS} = -10V)$   
 $R_{DS(ON)} < 130m\Omega (V_{GS} = -10V)$   
 $R_{DS(ON)} < 200m\Omega (V_{GS} = -4.5V)$

TO-236  
(SOT-23)  
Top View



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

| Parameter                              | Symbol         | Maximum    | Units      |
|----------------------------------------|----------------|------------|------------|
| Drain-Source Voltage                   | $V_{DS}$       | -30        | V          |
| Gate-Source Voltage                    | $V_{GS}$       | $\pm 20$   | V          |
| Continuous Drain Current <sup>A</sup>  | $I_D$          | -2.6       | A          |
| $T_A=25^\circ C$                       |                |            |            |
| $T_A=70^\circ C$                       |                | -2.2       |            |
| Pulsed Drain Current <sup>B</sup>      | $I_{DM}$       | -20        |            |
| Power Dissipation <sup>A</sup>         | $P_D$          | 1.4        | W          |
| $T_A=25^\circ C$                       |                |            |            |
| $T_A=70^\circ C$                       |                | 1          |            |
| Junction and Storage Temperature Range | $T_J, T_{STG}$ | -55 to 150 | $^\circ C$ |

#### Thermal Characteristics

| Parameter                                | Symbol          | Typ | Max | Units        |
|------------------------------------------|-----------------|-----|-----|--------------|
| Maximum Junction-to-Ambient <sup>A</sup> | $R_{\theta JA}$ | 70  | 90  | $^\circ C/W$ |
| $t \leq 10s$                             |                 |     |     |              |
| Maximum Junction-to-Ambient <sup>A</sup> | $R_{\theta JA}$ | 100 | 125 | $^\circ C/W$ |
| Steady-State                             |                 |     |     |              |
| Maximum Junction-to-Lead <sup>C</sup>    | $R_{\theta JL}$ | 63  | 80  | $^\circ C/W$ |
| Steady-State                             |                 |     |     |              |

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        | $I_D=-250\mu\text{A}$ , $V_{GS}=0\text{V}$                                           | -30 |       |           | V                |
| $I_{DSS}$                   | Zero Gate Voltage Drain Current       | $V_{DS}=-24\text{V}$ , $V_{GS}=0\text{V}$<br>$T_J=55^{\circ}\text{C}$                |     |       | -1<br>-5  | $\mu\text{A}$    |
| $I_{GSS}$                   | Gate-Body leakage current             | $V_{DS}=0\text{V}$ , $V_{GS}=\pm 20\text{V}$                                         |     |       | $\pm 100$ | nA               |
| $V_{GS(th)}$                | Gate Threshold Voltage                | $V_{DS}=V_{GS}$ , $I_D=-250\mu\text{A}$                                              | -1  | -1.9  | -3        | V                |
| $I_{D(ON)}$                 | On state drain current                | $V_{GS}=-4.5\text{V}$ , $V_{DS}=-5\text{V}$                                          | -5  |       |           | A                |
| $R_{DS(ON)}$                | Static Drain-Source On-Resistance     | $V_{GS}=-10\text{V}$ , $I_D=-2.6\text{A}$<br>$T_J=125^{\circ}\text{C}$               |     | 97    | 130       | $\text{m}\Omega$ |
|                             |                                       | $V_{GS}=-4.5\text{V}$ , $I_D=-2\text{A}$                                             |     | 135   | 150       | $\text{m}\Omega$ |
|                             |                                       |                                                                                      |     | 166   | 200       | $\text{m}\Omega$ |
| $g_{FS}$                    | Forward Transconductance              | $V_{DS}=-5\text{V}$ , $I_D=-2.5\text{A}$                                             | 3   | 3.8   |           | S                |
| $V_{SD}$                    | Diode Forward Voltage                 | $I_S=-1\text{A}$ , $V_{GS}=0\text{V}$                                                |     | -0.82 | -1        | V                |
| $I_S$                       | Maximum Body-Diode Continuous Current |                                                                                      |     |       | -2        | A                |
| <b>DYNAMIC PARAMETERS</b>   |                                       |                                                                                      |     |       |           |                  |
| $C_{iss}$                   | Input Capacitance                     | $V_{GS}=0\text{V}$ , $V_{DS}=-15\text{V}$ , $f=1\text{MHz}$                          |     | 302   | 370       | pF               |
| $C_{oss}$                   | Output Capacitance                    |                                                                                      |     | 50.3  |           | pF               |
| $C_{rss}$                   | Reverse Transfer Capacitance          |                                                                                      |     | 37.8  |           | pF               |
| $R_g$                       | Gate resistance                       | $V_{GS}=0\text{V}$ , $V_{DS}=0\text{V}$ , $f=1\text{MHz}$                            |     | 12    | 18        | $\Omega$         |
| <b>SWITCHING PARAMETERS</b> |                                       |                                                                                      |     |       |           |                  |
| $Q_g(10)$                   | Total Gate Charge(10V)                | $V_{GS}=-10\text{V}$ , $V_{DS}=-15\text{V}$ , $I_D=-2.6\text{A}$                     |     | 6.8   | 9         | nC               |
| $Q_g(4.5)$                  | Total Gate Charge(4.5V)               |                                                                                      |     | 2.4   |           | nC               |
| $Q_{gs}$                    | Gate Source Charge                    |                                                                                      |     | 1.6   |           | nC               |
| $Q_{gd}$                    | Gate Drain Charge                     |                                                                                      |     | 0.95  |           | nC               |
| $t_{D(on)}$                 | Turn-On DelayTime                     | $V_{GS}=-10\text{V}$ , $V_{DS}=-15\text{V}$ , $R_L=5.8\Omega$ ,<br>$R_{GEN}=3\Omega$ |     | 7.5   |           | ns               |
| $t_r$                       | Turn-On Rise Time                     |                                                                                      |     | 3.2   |           | ns               |
| $t_{D(off)}$                | Turn-Off DelayTime                    |                                                                                      |     | 17    |           | ns               |
| $t_f$                       | Turn-Off Fall Time                    |                                                                                      |     | 6.8   |           | ns               |
| $t_{rr}$                    | Body Diode Reverse Recovery Time      | $I_F=-2.6\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$                                 |     | 16.8  | 22        | ns               |
| $Q_{rr}$                    | Body Diode Reverse Recovery Charge    | $I_F=-2.6\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$                                 |     | 10    |           | 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 given application depends on the user's specific board design. The current rating is based on the  $\leq 10\text{s}$  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

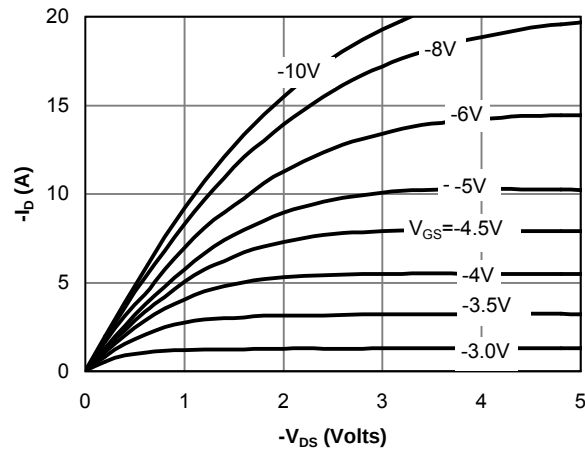


Fig 1: On-Region Characteristics

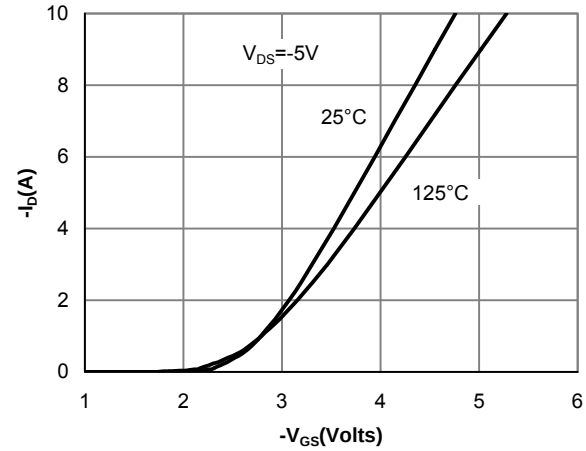


Figure 2: Transfer Characteristics

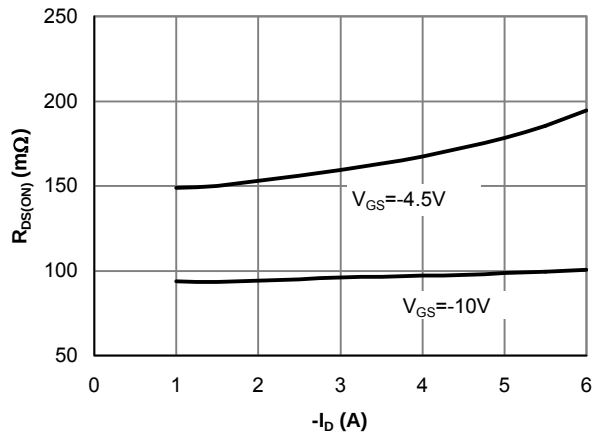


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

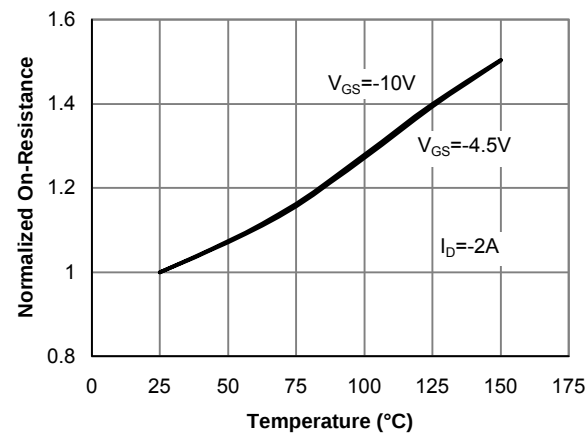


Figure 4: On-Resistance vs. Junction Temperature

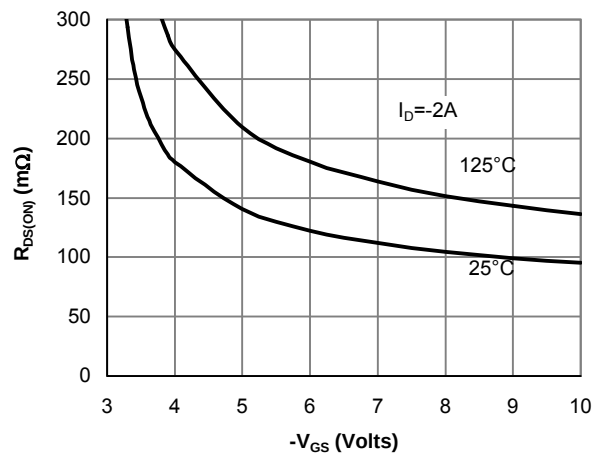


Figure 5: On-Resistance vs. Gate-Source Voltage

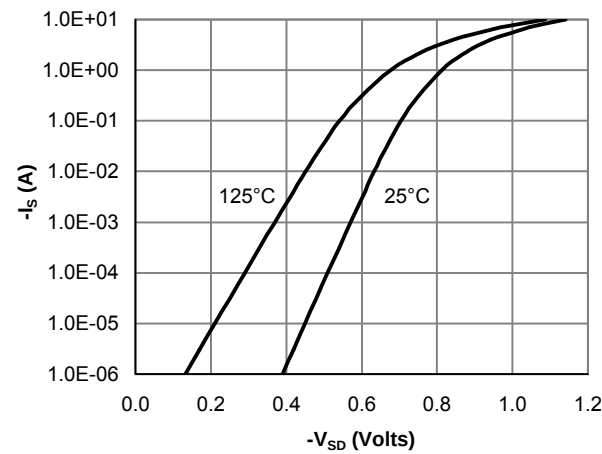


Figure 6: Body-Diode Characteristics

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