



**THE DATASHEET OF  
AO5401EL**





**AO5401E**

**P-Channel Enhancement Mode Field Effect Transistor**

**General Description**

The AO5401E/L 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. AO5401E and AO5401EL are electrically identical.

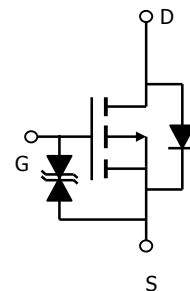
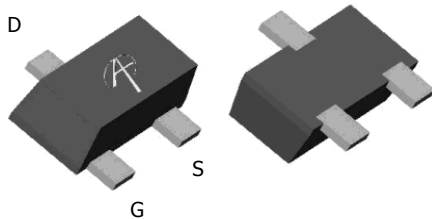
- RoHS compliant
- AO5401EL is Halogen Free

**Features**

- $V_{DS}$  (V) = -20V
- $I_D$  = -0.5 A ( $V_{GS}$  = -4.5V)
- $R_{DS(ON)} < 0.8\Omega$  ( $V_{GS}$  = -4.5V)
- $R_{DS(ON)} < 1\Omega$  ( $V_{GS}$  = -2.5V)
- $R_{DS(ON)} < 1.3\Omega$  ( $V_{GS}$  = -1.8V)

**ESD PROTECTED!**

**SC89-3L**  
**Top View**



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

Parameter	Symbol	10 Sec	Steady State	Units	
Drain-Source Voltage	$V_{DS}$	-20		V	
Gate-Source Voltage	$V_{GS}$	$\pm 8$		V	
Continuous Drain Current <sup>AF</sup>	$I_D$	$T_A=25^\circ\text{C}$	-0.5	-0.5	A
		$T_A=70^\circ\text{C}$	-0.45	-0.40	
Pulsed Drain Current <sup>B</sup>	$I_{DM}$	-1			
Power Dissipation <sup>A</sup>	$P_D$	$T_A=25^\circ\text{C}$	0.38	0.28	W
		$T_A=70^\circ\text{C}$	0.24	0.18	
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>	$R_{\theta JA}$	275	330	$^\circ\text{C/W}$
Maximum Junction-to-Ambient <sup>A</sup>				
Maximum Junction-to-Lead <sup>C</sup>	$R_{\theta JL}$	300	350	$^\circ\text{C/W}$

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	$V_{DS}=-20\text{V}$ , $V_{GS}=0\text{V}$			1	$\mu\text{A}$
		$T_J=55^\circ\text{C}$			5	
$I_{GSS}$	Gate-Body leakage current	$V_{DS}=10\text{V}$ , $V_{GS}=\pm 4.5\text{V}$			$\pm 1$	$\mu\text{A}$
		$V_{DS}=10\text{V}$ , $V_{GS}=\pm 8\text{V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS}=V_{GS}$ , $I_D=-250\mu\text{A}$	-0.4	-0.5	-0.9	V
$I_{D(ON)}$	On state drain current	$V_{GS}=-4.5\text{V}$ , $V_{DS}=-5\text{V}$	-1			A
$R_{DS(ON)}$	Static Drain-Source On-Resistance	$V_{GS}=-4.5\text{V}$ , $I_D=-0.5\text{A}$		0.53	0.8	$\Omega$
		$T_J=125^\circ\text{C}$		0.75	0.95	
		$V_{GS}=-2.5\text{V}$ , $I_D=-0.5\text{A}$		0.72	1	$\Omega$
		$V_{GS}=-1.8\text{V}$ , $I_D=-0.3\text{A}$		0.95	1.3	$\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS}=-5\text{V}$ , $I_D=-0.5\text{A}$		0.9		S
$V_{SD}$	Diode Forward Voltage	$I_S=-0.1\text{A}$ , $V_{GS}=0\text{V}$		-0.66	-1	V
$I_S$	Maximum Body-Diode Continuous Current				-0.5	A
<b>DYNAMIC PARAMETERS</b>						
$C_{iss}$	Input Capacitance	$V_{GS}=0\text{V}$ , $V_{DS}=-10\text{V}$ , $f=1\text{MHz}$		72	100	$\text{pF}$
$C_{oss}$	Output Capacitance			17		$\text{pF}$
$C_{riss}$	Reverse Transfer Capacitance			9		$\text{pF}$
<b>SWITCHING PARAMETERS</b>						
$t_{D(on)}$	Turn-On Delay Time	$V_{GS}=-4.5\text{V}$ , $V_{DS}=-10\text{V}$ , $R_L=50\Omega$ , $R_{GEN}=3\Omega$		60.5		ns
$t_r$	Turn-On Rise Time			150		ns
$t_{D(off)}$	Turn-Off Delay Time			612		ns
$t_f$	Turn-Off Fall Time			436		ns
$t_{rr}$	Body Diode Reverse Recovery Time	$I_F=-0.5\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$		27	35	ns
$Q_{rr}$	Body Diode Reverse Recovery Charge	$I_F=-0.5\text{A}$ , $dI/dt=100\text{A}/\mu\text{s}$		8.3		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  $t \leq 10\text{s}$  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  $<300 \mu\text{s}$  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

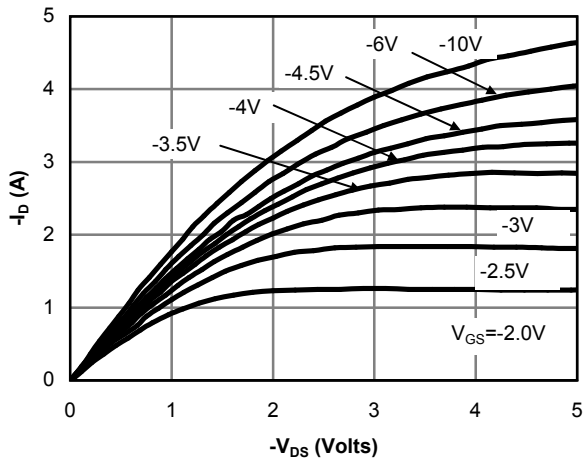


Figure 1: On-Region Characteristics

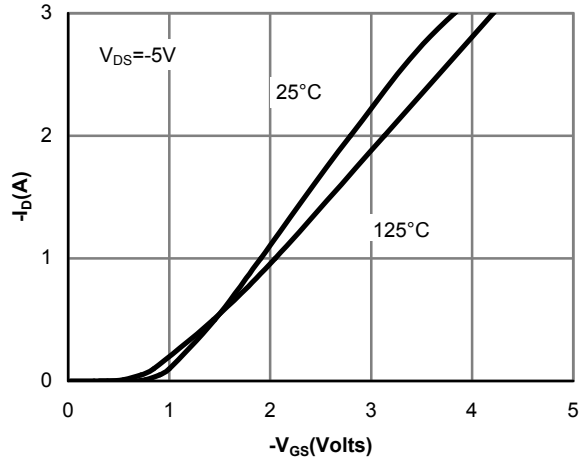


Figure 2: Transfer Characteristics

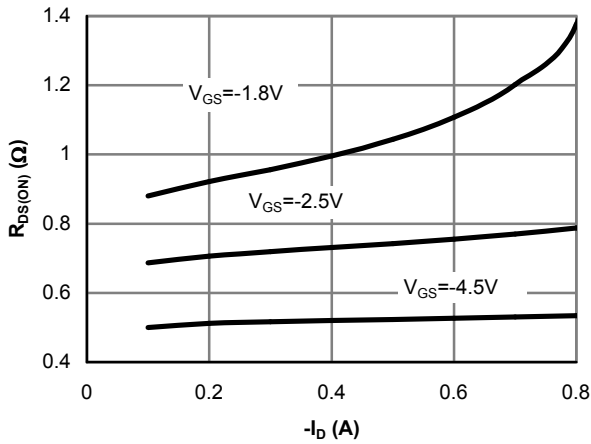


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

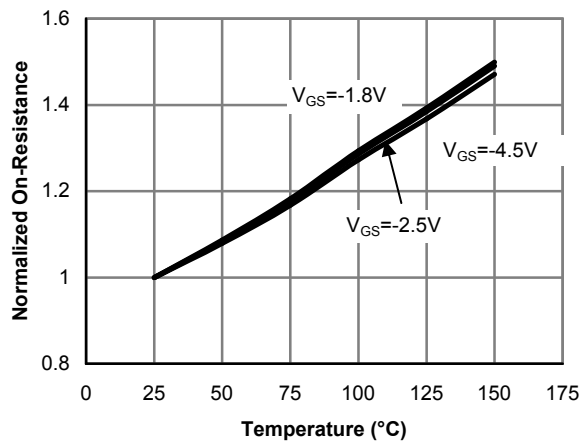


Figure 4: On-Resistance vs. Junction Temperature

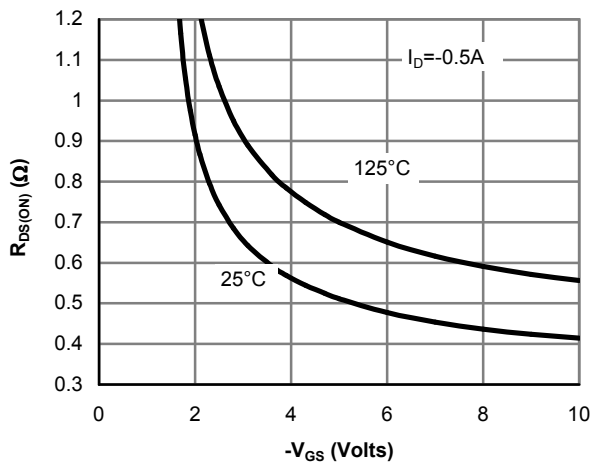


Figure 5: On-Resistance vs. Gate-Source Voltage

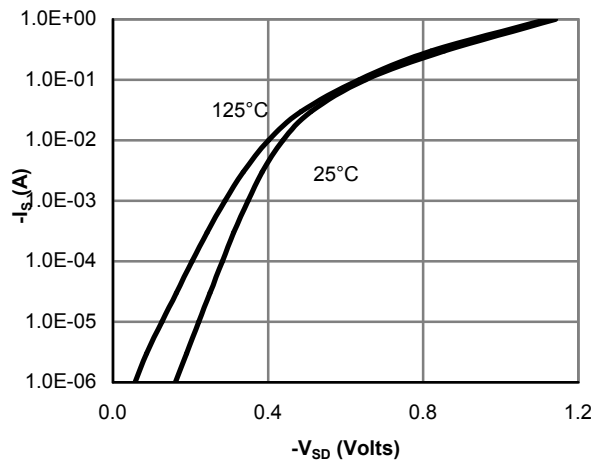


Figure 6: Body-Diode Characteristics

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

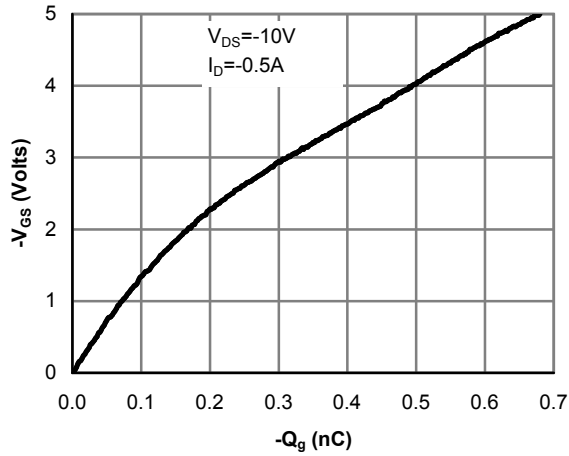


Figure 7: Gate-Charge Characteristics

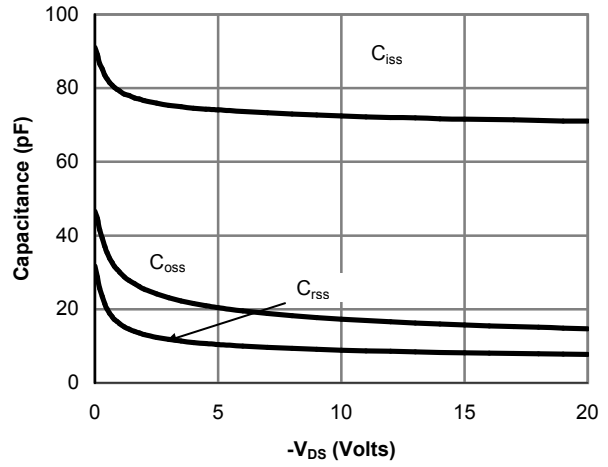


Figure 8: Capacitance Characteristics

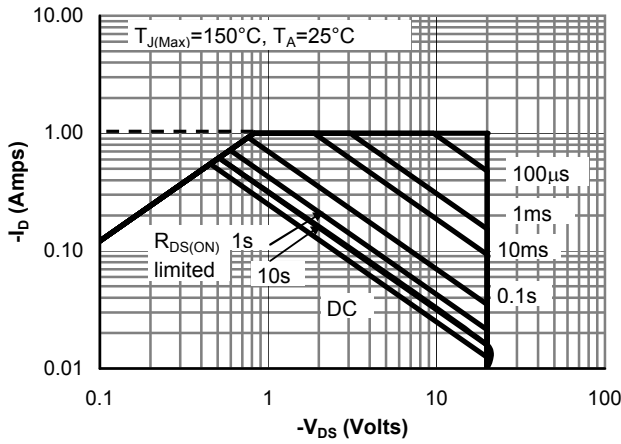


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

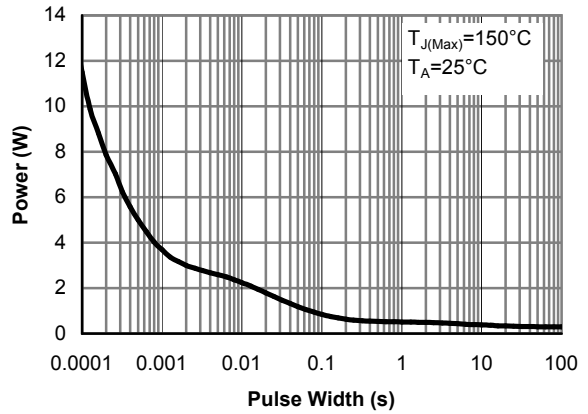


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

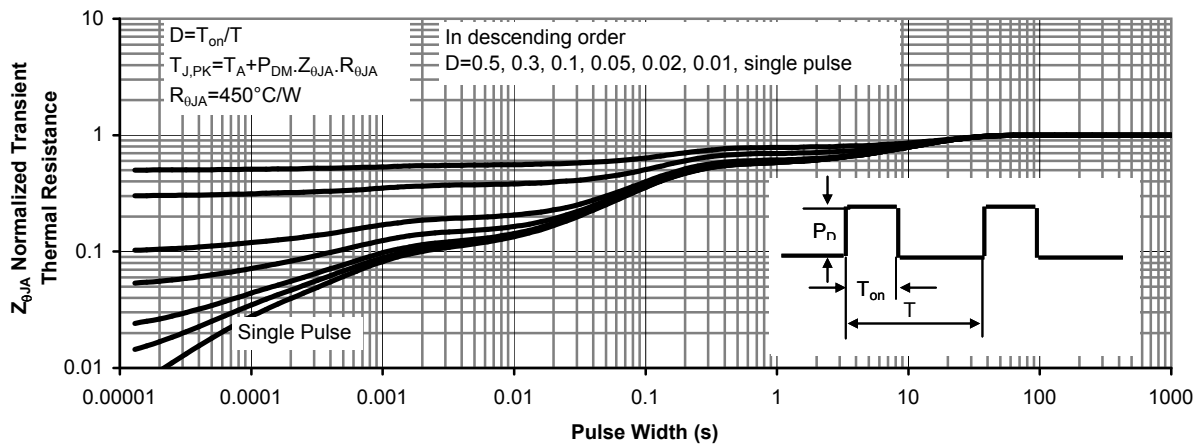
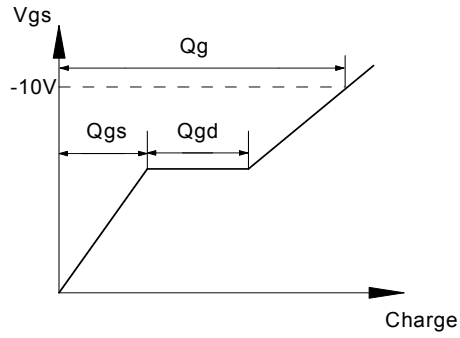
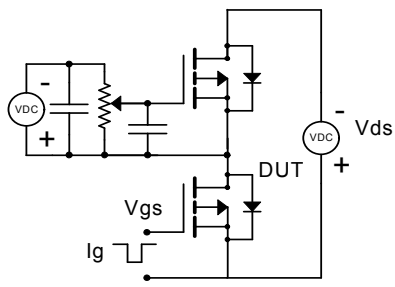
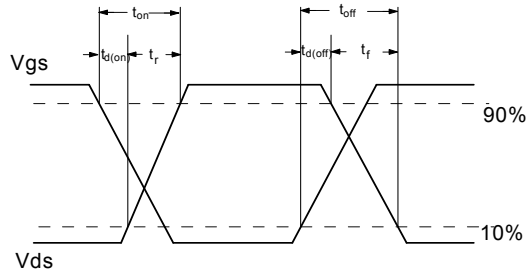
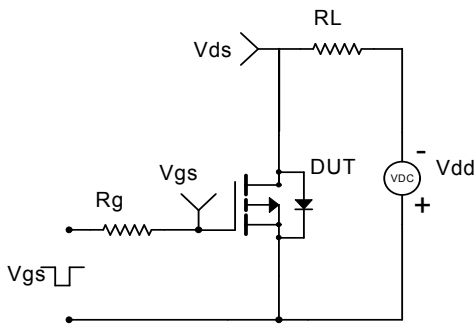


Figure 11: Normalized Maximum Transient Thermal Impedance

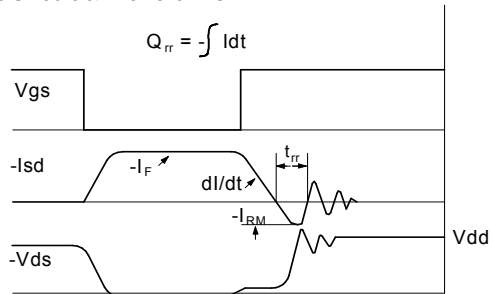
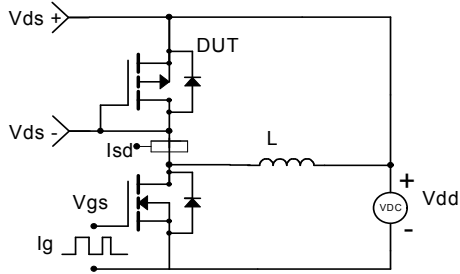
Gate Charge Test Circuit & Waveform



Resistive Switching Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms



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