ALPHA & OMEGA SEMICONDUCTOR

AO4435

30V P-Channel MOSFET

General Description

The AO4435 uses advanced trench technology to provide excellent $R_{DS(ON)}$, and ultra-low low gate charge with a 25V gate rating. This device is suitable for use as a load switch or in PWM applications.

-RoHS Compliant
-AO4435 is Halogen Free

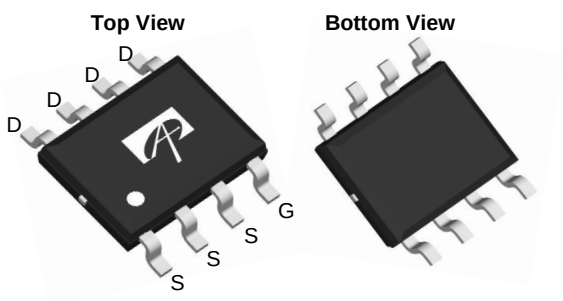
Product Summary

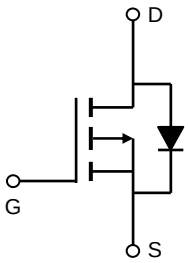
V_{DS} = -30V
I_D = -10.5A (V_{GS} = -20V)
$R_{DS(ON)}$ < 14mΩ (V_{GS} = -20V)
$R_{DS(ON)}$ < 18mΩ (V_{GS} = -10V)
$R_{DS(ON)}$ < 36mΩ (V_{GS} = -5V)

100% UIS Tested
100% Rg Tested

Green Product

SOIC-8





Absolute Maximum Ratings T_A=25°C unless otherwise noted

Parameter		Symbol	Maximum	Units
Drain-Source Voltage		V_{DS}	-30	V
Gate-Source Voltage		V_{GS}	±25	V
Continuous Drain Current [A]	T_A=25°C	I_D	-10.5	A
	T_A=70°C		-8	
Pulsed Drain Current [B]		I_{DM}	-80	
Power Dissipation [A]	T_A=25°C	P_D	3.1	W
	T_A=70°C		2.0	
Avalanche Current [B]		I_{AR}	-20	A
Repetitive avalanche energy 0.3mH [B]		E_{AR}	60	mJ
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 150	°C

Thermal Characteristics

Parameter		Symbol	Typ	Max	Units
Maximum Junction-to-Ambient [A]	t ≤ 10s	$R_{\theta JA}$	32	40	°C/W
Maximum Junction-to-Ambient [A]	Steady State		60	75	°C/W
Maximum Junction-to-Lead [C]	Steady State	$R_{\theta JL}$	17	24	°C/W

Electrical Characteristics (T_J=25°C unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
STATIC PARAMETERS						
BV_{DSS}	Drain-Source Breakdown Voltage	I_D = -250µA, V_{GS} = 0V	-30			V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = -30V, V_{GS} = 0V			-1	µA
		T_J = 55°C			-5	
I_{GSS}	Gate-Body leakage current	V_{DS} = 0V, V_{GS} = ±25V			±100	nA
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS} = V_{GS} I_D = -250µA	-1.7	-2.3	-3	V
$I_{D(ON)}$	On state drain current	V_{GS} = -10V, V_{DS} = -5V	-80			A
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS} = -20V, I_D = -11A		11	14	mΩ
		T_J=125°C		15	19	
		V_{GS} = -10V, I_D = -10A		15	18	
		V_{GS} = -5V, I_D = -5A		27	36	
g_{FS}	Forward Transconductance	V_{DS} = -5V, I_D = -10A		22		S
V_{SD}	Diode Forward Voltage	I_S = -1A,V_{GS} = 0V		-0.74	-1	V
I_S	Maximum Body-Diode Continuous Current				-3.5	A
DYNAMIC PARAMETERS						
C_{iss}	Input Capacitance	V_{GS}=0V, V_{DS}=-15V, f=1MHz		1130	1400	pF
C_{oss}	Output Capacitance			240		pF
C_{rss}	Reverse Transfer Capacitance			155		pF
R_g	Gate resistance	V_{GS}=0V, V_{DS}=0V, f=1MHz	1	5.8	8	Ω
SWITCHING PARAMETERS						
$Q_{g(10V)}$	Total Gate Charge	V_{GS}=-10V, V_{DS}=-15V, I_D=-10A		18	24	nC
$Q_{g(4.5V)}$	Total Gate Charge			9.5		
Q_{gs}	Gate Source Charge			5.5		nC
Q_{gd}	Gate Drain Charge			3.3		nC
$t_{D(on)}$	Turn-On DelayTime	V_{GS}=-10V, V_{DS}=-15V, R_L=1.5Ω, R_{GEN}=3Ω		8.7		ns
t_r	Turn-On Rise Time			8.5		ns
$t_{D(off)}$	Turn-Off DelayTime			18		ns
t_f	Turn-Off Fall Time			7		ns
t_{rr}	Body Diode Reverse Recovery Time	I_F=-10A, dI/dt=100A/µs		25	30	ns
Q_{rr}	Body Diode Reverse Recovery Charge	I_F=-10A, dI/dt=100A/µs		12		nC

A: The value of $R_{\theta JA}$ is measured with the device mounted on 1 in^2 FR-4 board with 2oz. Copper, in a still air environment with T_A = 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 $R_{\theta JA}$ is the sum of the thermal impedence from junction to lead $R_{\theta JL}$ and lead to ambient.

D. The static characteristics in Figures 1 to 6 are obtained using <300µs pulses, duty cycle 0.5% max.

E. These tests are performed with the device mounted on 1 in^2 FR-4 board with 2oz. Copper, in a still air environment with T_A=25°C. The SOA curve provides a single pulse rating.

F. The current rating is based on the t ≤ 10s thermal resistance rating.

G. E_{AR} and I_{AR} ratings are based on low frequency and duty cycles to keep T_j=25C.

Rev7: Nov. 2010

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

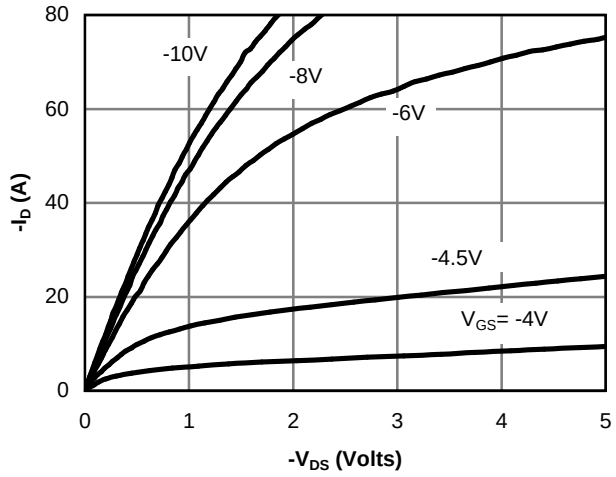


Figure 1: On-Region Characteristics

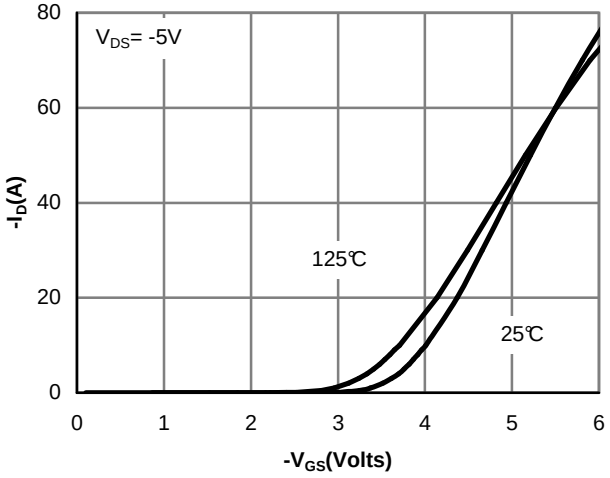


Figure 2: Transfer Characteristics

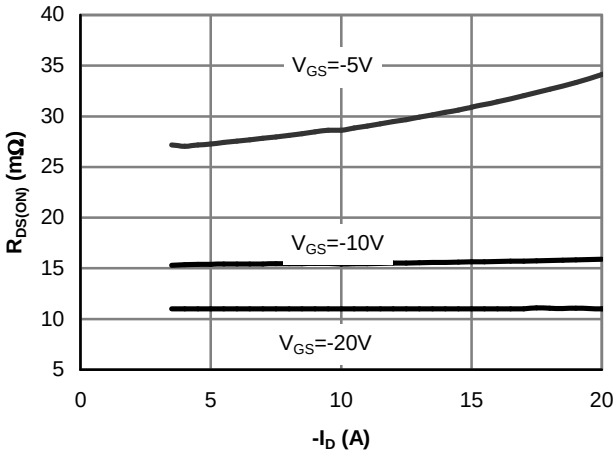


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

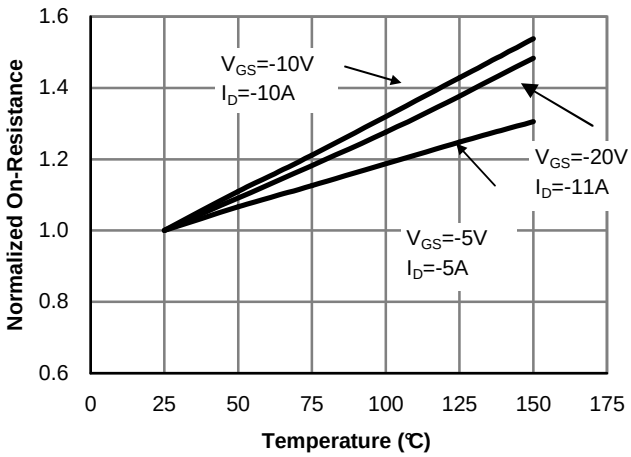


Figure 4: On-Resistance vs. Junction Temperature

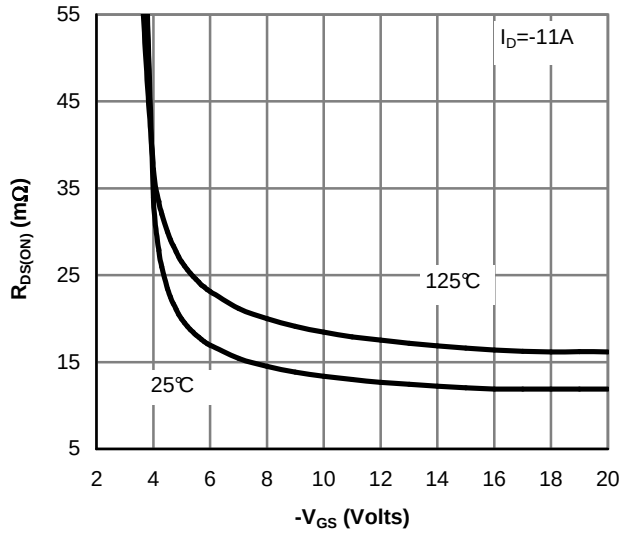


Figure 5: On-Resistance vs. Gate-Source Voltage

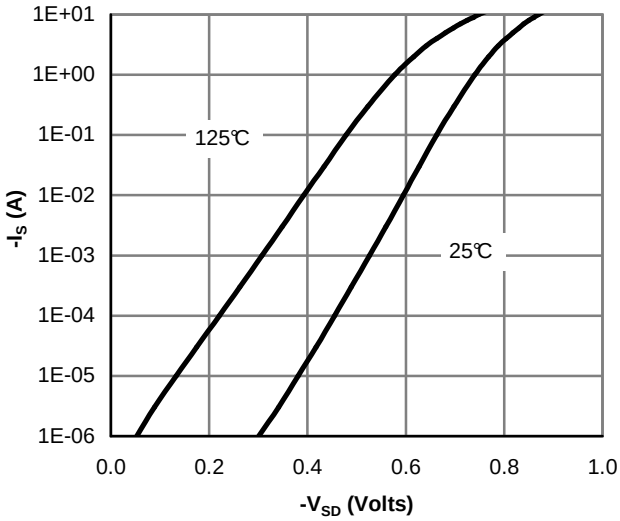


Figure 6: Body-Diode Characteristics

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

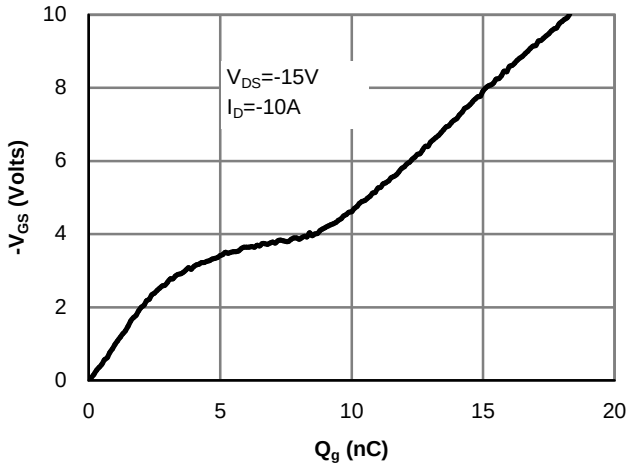


Figure 7: Gate-Charge Characteristics

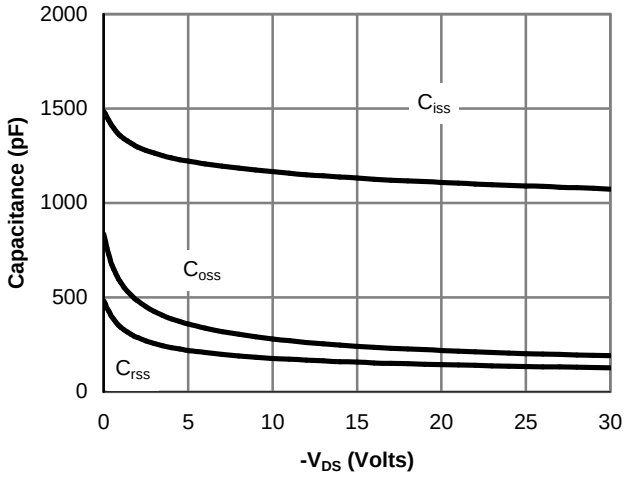


Figure 8: Capacitance Characteristics

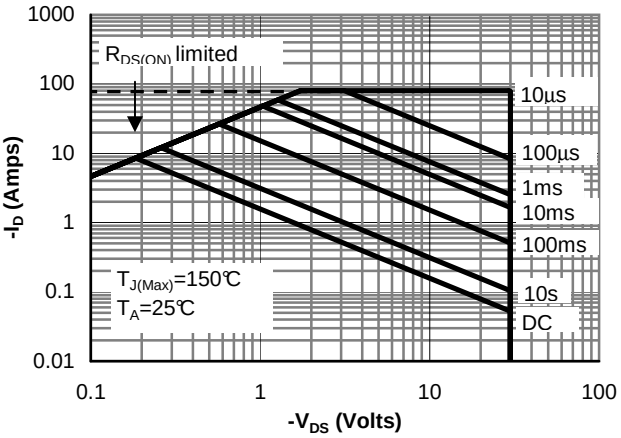


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

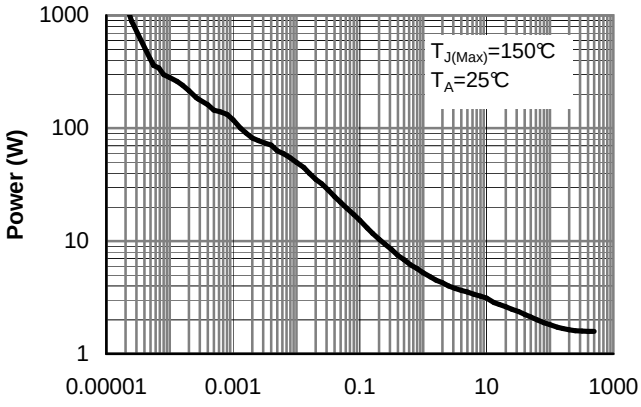


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

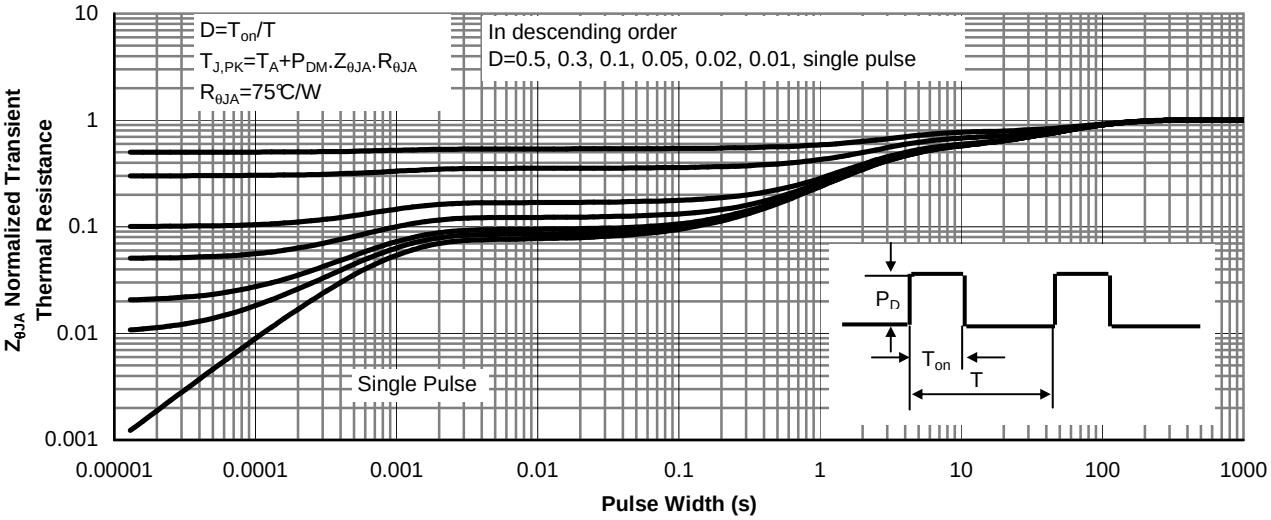
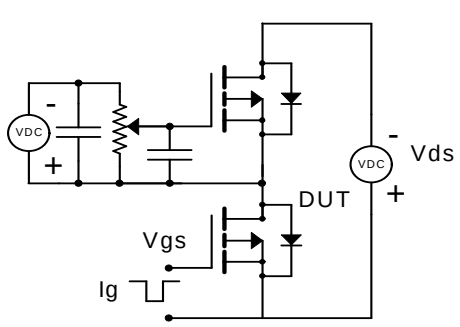
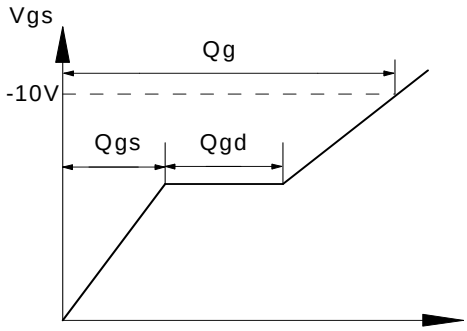


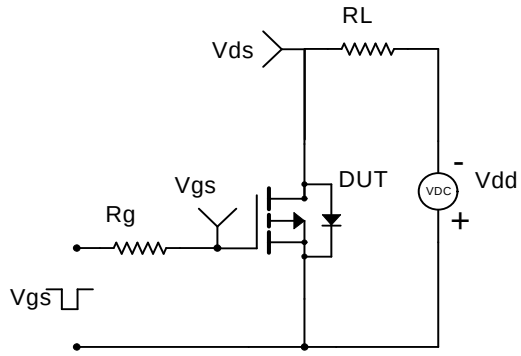
Figure 11: Normalized Maximum Transient Thermal Impedance(Note E)

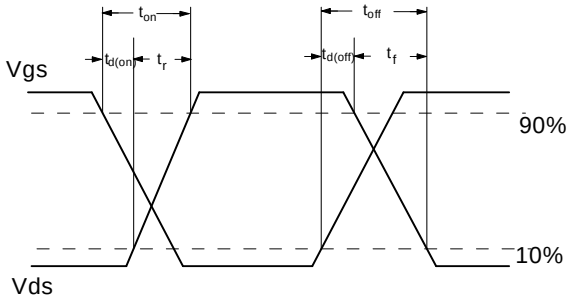
Gate Charge Test Circuit & Waveform



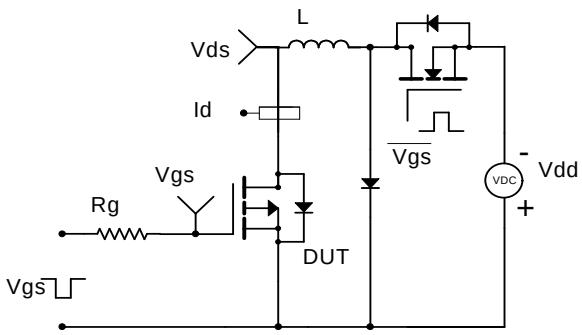


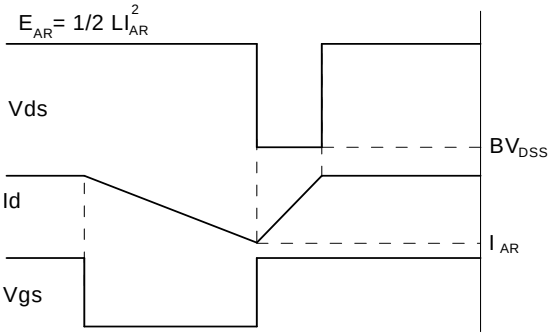
Resistive Switching Test Circuit & Waveforms



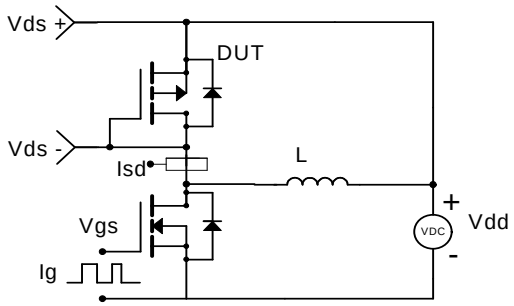


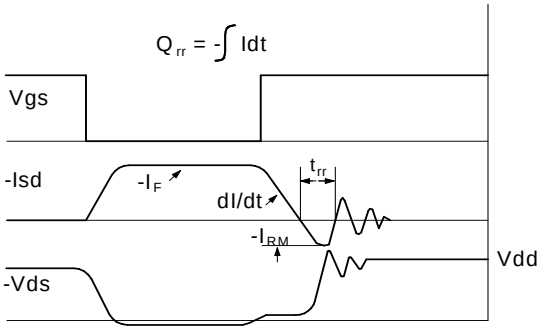
Unclamped Inductive Switching (UIS) Test Circuit & Waveforms





Diode Recovery Test Circuit & Waveforms

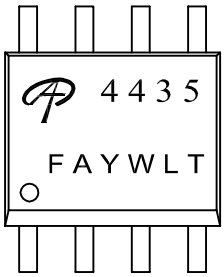




ALPHA & OMEGA SEMICONDUCTOR

Document No.	PD-00690
Version	B
Title	AO4435 Marking Description

SO-8 PACKAGE MARKING DESCRIPTION



Green product

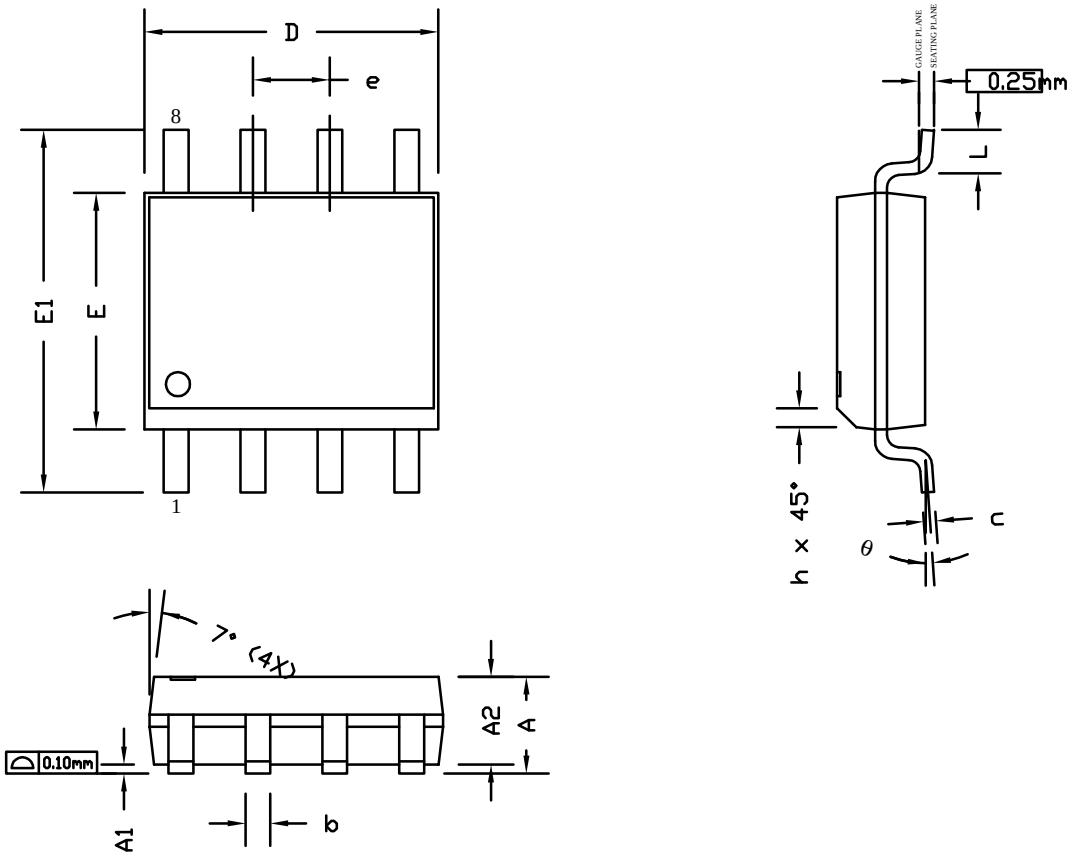
NOTE:
LOGO - AOS Logo
4435 - Part number code
F - Fab code
A - Assembly location code
Y - Year code
W - Week code
L&T - Assembly lot code

PART NO.	DESCRIPTION	CODE
AO4435	Green product	4435
AO4435L	Green product	4435

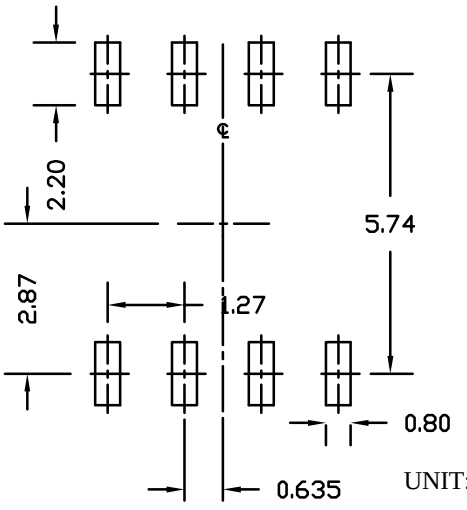
ALPHA & OMEGA SEMICONDUCTOR

Document No.	PO-00004
Version	I

SO8 PACKAGE OUTLINE



RECOMMENDED LAND PATTERN



UNIT: mm

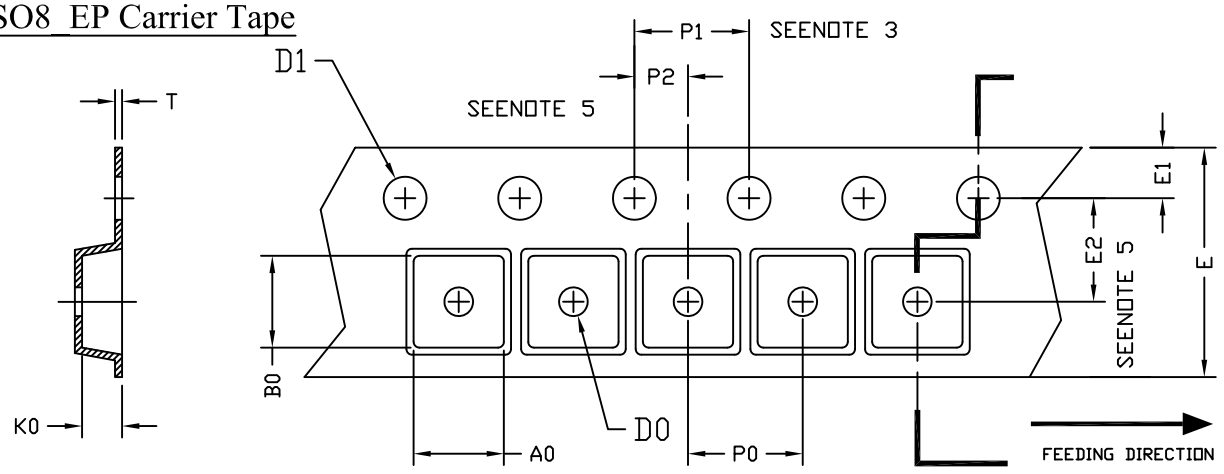
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	1.65	1.75	0.053	0.065	0.069
A1	0.10	0.15	0.25	0.004	0.006	0.010
A2	1.25	1.50	1.65	0.049	0.059	0.065
b	0.31	0.41	0.51	0.012	0.016	0.020
c	0.17	0.20	0.25	0.007	0.008	0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	3.80	3.90	4.00	0.150	0.154	0.157
e	1.27 BSC			0.050 BSC		
E1	5.80	6.00	6.20	0.228	0.236	0.244
h	0.25	0.30	0.50	0.010	0.012	0.020
L	0.40	0.69	1.27	0.016	0.027	0.050
θ	0°	4°	8°	0°	4°	8°

NOTE
1. ALL DIMENSIONS ARE IN MILLMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS.
   MOLD FLASH AT THE NON-LEAD SIDES SHOULD BE LESS THAN 6 MILS EACH.
4. DIMENSION L IS MEASURED IN GAUGE PLANE.
5. CONTROLLING DIMENSION IS MILLIMETER.
   CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.

ALPHA & OMEGA
SEMICONDUCTOR, LTD.

SO8/SO8_EP Tape and Reel Data

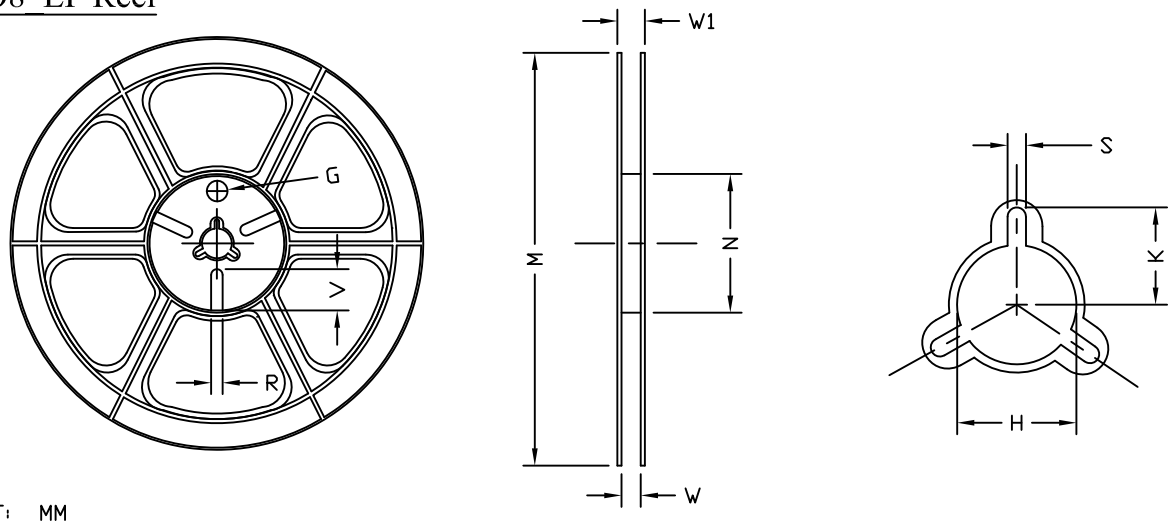
SO8/SO8_EP Carrier Tape



UNIT: MM

PACKAGE	A0	B0	K0	D0	D1	E	E1	E2	P0	P1	P2	T
SO-8 (12 mm)	6.40 ±0.10	5.20 ±0.10	2.10 ±0.10	1.60 ±0.10	1.50 +0.10	12.00 ±0.30	1.75 ±0.10	5.50 ±0.05	8.00 ±0.10	4.00 ±0.10	2.00 ±0.05	0.25 ±0.05

SO8/SO8_EP Reel



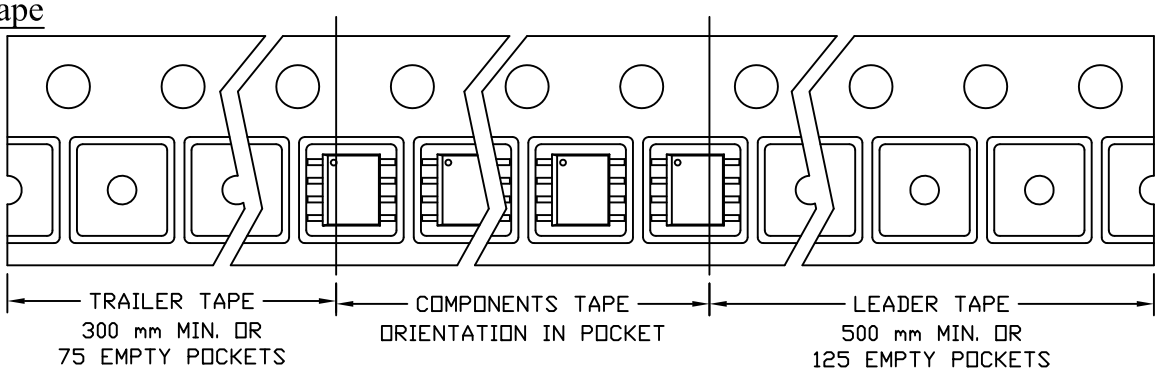
UNIT: MM

TAPE SIZE	REEL SIZE	M	N	W	W1	H	K	S	G	R	V
12 mm	ø330	ø330.00 ±0.50	ø97.00 ±0.10	13.00 ±0.30	17.40 ±1.00	ø13.00 +0.50 −0.20	10.60	2.00 ±0.50	---	---	---

SO8/SO8_EP Tape

Leader / Trailer & Orientation

Unit Per Reel: 3000pcs



ALPHA & OMEGA SEMICONDUCTOR

AOS Semiconductor
Product Reliability Report

AO4435/L, rev C

Plastic Encapsulated Device

ALPHA & OMEGA Semiconductor, Inc

www.aosmd.com

This AOS product reliability report summarizes the qualification result for AO4435/L. Accelerated environmental tests are performed on a specific sample size, and then followed by electrical test at end point. Review of final electrical test result confirms that AO4435/L passes AOS quality and reliability requirements. The released product will be categorized by the process family and be monitored on a quarterly basis for continuously improving the product quality.

Table of Contents:

I. Product Description:

The AO4435/L uses advanced trench technology to provide excellent $R_{DS(ON)}$, and ultra-low low gate charge with a 25V gate rating. This device is suitable for use as a load switch or in PWM applications. AO4435 and AO4435L are electrically identical.

-RoHS Compliant
-AO4435L is Halogen Free

Detailed information refers to datasheet.

II. Die / Package Information:

	AO4435/L
Process	Standard sub-micron Low voltage P channel
Package Type	8 lead SOIC
Lead Frame	Copper
Die Attach	Ag Epoxy
Bonding Wire	Cu wire
Mold Material	Epoxy resin with silica filler
MSL (moisture sensitive level)	Level 1 based on J-STD-020

Note * based on information provided by assembler and mold compound supplier

ALPHA & OMEGA SEMICONDUCTOR

III. Result of Reliability Stress for AO4435/L

Test Item	Test Condition	Time Point	Lot Attribution	Total Sample size	Number of Failures	Standard
MSL Precondition	168hr 85℃ /85%RH +3 cycle reflow@260℃	-	29 lots	3575pcs	0	JESD22-A113
HTGB	Temp = 150 °c, Vgs=100% of Vgsmax	168hrs 500 hrs 1000 hrs	1 lot 3 lots (Note A*)	308pcs 77pcs / lot	0	JESD22-A108
HTRB	Temp = 150 °c, Vds=80% of Vdsmax	168hrs 500 hrs 1000 hrs	1 lot 3 lots (Note A*)	308pcs 77pcs / lot	0	JESD22-A108
HAST	130 +/- 2°c, 85%RH, 33.3 psi, Vgs = 80% of Vgs max	100 hrs	16 lots (Note A*)	880pcs 55 pcs / lot	0	JESD22-A110
Pressure Pot	121°c, 29.7psi, RH=100%	96 hrs	20 lots (Note A*)	1100pcs 55 pcs / lot	0	JESD22-A102
Temperature Cycle	-65°c to 150°c, air to air	250 / 500 cycles	29 lots (Note A*)	1595pcs 55 pcs / lot	0	JESD22-A104

Note A: The reliability data presents total of available generic data up to the published date.

IV. Reliability Evaluation

FIT rate (per billion): 7
MTTF = 15704 years

The presentation of FIT rate for the individual product reliability is restricted by the actual burn-in sample size of the selected product (AO4435/L). Failure Rate Determination is based on JEDEC Standard JESD 85. FIT means one failure per billion hours.

Failure Rate = $Chi^2 \times 10^9$ **/ [**2 (N) (H) (Af)**]**
= 1.83×10^9 **/ [**2 x (2x77x168+3x2x77x1000) x 258**]** = 7
MTTF = 10^9 / FIT = 1.38 x 10^8hrs = 15704 years

Chi² = Chi Squared Distribution, determined by the number of failures and confidence interval
N = Total Number of units from HTRB and HTGB tests
H = Duration of HTRB/HTGB testing
Af = Acceleration Factor from Test to Use Conditions (Ea = 0.7eV and Tuse = 55℃)
Acceleration Factor [Af**]** = **Exp** [Ea / **k** (1/Tj u – 1/Tj s)]

Acceleration Factor ratio list:

	55 deg C	70 deg C	85 deg C	100 deg C	115 deg C	130 deg C	150 deg C
Af	258	87	32	13	5.64	2.59	1

Tj s = Stressed junction temperature in degree (Kelvin), K = C+273.16
Tj u = The use junction temperature in degree (Kelvin), K = C+273.16
K = Boltzmann's constant, 8.617164 X 10-5eV / K