

General Description

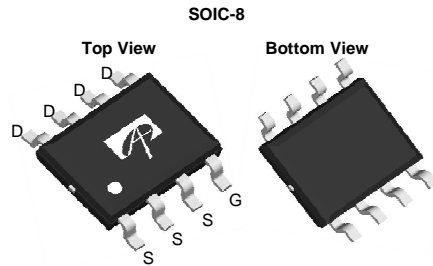
The AO4407 combines advanced trench MOSFET technology with a low resistance package to provide extremely low $R_{DS(ON)}$. This device is ideal for load switch and battery protection applications.

* RoHS and Halogen-Free Compliant

Product Summary

V_{DS}	-30V
I_D (at $V_{GS}=-20V$)	-12A
$R_{DS(ON)}$ (at $V_{GS}=-20V$)	< 13m Ω
$R_{DS(ON)}$ (at $V_{GS}=-10V$)	< 14m Ω
$R_{DS(ON)}$ (at $V_{GS}=-5V$)	< 30m Ω

100% UIS Tested
 100% R_g Tested



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

Parameter	Symbol	Maximum	Units
Drain-Source Voltage	V_{DS}	-30	V
Gate-Source Voltage	V_{GS}	± 25	V
Continuous Drain Current	I_D	$T_A=25^\circ\text{C}$	-12
		$T_A=70^\circ\text{C}$	-10
Pulsed Drain Current ^C	I_{DM}	-60	A
Avalanche Current ^C	I_{AS}, I_{AR}	26	A
Avalanche energy $L=0.3\text{mH}$ ^C	E_{AS}, E_{AR}	101	mJ
Power Dissipation ^B	P_D	$T_A=25^\circ\text{C}$	3.1
		$T_A=70^\circ\text{C}$	2
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 ^A	$R_{\theta JA}$	31	40	$^\circ\text{C/W}$
Maximum Junction-to-Ambient ^{A D}		59	75	$^\circ\text{C/W}$
Maximum Junction-to-Lead	$R_{\theta JL}$	16	24	$^\circ\text{C/W}$

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 T _J =55°C			-1 -5	μA
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	-2.25	-2.8	V
I _{D(ON)}	On state drain current	V _{GS} =-10V, V _{DS} =-5V	-60			A
R _{DS(ON)}	Static Drain-Source On-Resistance	V _{GS} =-20V, I _D =-12A		8.5	13	mΩ
		V _{GS} =-10V, I _D =-12A T _J =125°C		10 12	14 19	mΩ
		V _{GS} =-5V, I _D =-7A		19	30	mΩ
g _{FS}	Forward Transconductance	V _{DS} =-5V, I _D =-10.5A		27		S
V _{SD}	Diode Forward Voltage	I _S =-1A, V _{GS} =0V		-0.72	-1	V
I _S	Maximum Body-Diode Continuous Current				-4	A
DYNAMIC PARAMETERS						
C _{iss}	Input Capacitance	V _{GS} =0V, V _{DS} =-15V, f=1MHz		2060	2600	pF
C _{oss}	Output Capacitance			370		pF
C _{rss}	Reverse Transfer Capacitance			295		pF
R _g	Gate resistance	V _{GS} =0V, V _{DS} =0V, f=1MHz	1.2	2.4	3.6	Ω
SWITCHING PARAMETERS						
Q _g	Total Gate Charge	V _{GS} =-10V, V _{DS} =-15V, I _D =-12A	24	30	36	nC
Q _{gs}	Gate Source Charge			4.6		nC
Q _{gd}	Gate Drain Charge			10		nC
t _{D(on)}	Turn-On DelayTime	V _{GS} =-10V, V _{DS} =-15V, R _L =1.25Ω, R _{GEN} =3Ω		11		ns
t _r	Turn-On Rise Time			9.4		ns
t _{D(off)}	Turn-Off DelayTime			24		ns
t _f	Turn-Off Fall Time			12		ns
t _{rr}	Body Diode Reverse Recovery Time	I _F =-12A, di/dt=100A/μs		30	40	ns
Q _{rr}	Body Diode Reverse Recovery Charge	I _F =-12A, di/dt=100A/μs		22		nC

A. The value of R_{θJA} is measured with the device mounted on 1in² 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.

B. The power dissipation P_D is based on T_{J(MAX)}=150° C, using ≤ 10s junction-to-ambient thermal resistance.

C. Repetitive rating, pulse width limited by junction temperature T_{J(MAX)}=150° C. Ratings are based on low frequency and duty cycles to keep initial T_J=25° C.

D. The R_{θJA} is the sum of the thermal impedance from junction to lead R_{θJL} and lead to ambient.

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

F. These curves are based on the junction-to-ambient thermal impedance which is measured with the device mounted on 1in² FR-4 board with 2oz. Copper, assuming a maximum junction temperature of T_{J(MAX)}=150° C. The SOA curve provides a single pulse rating.

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

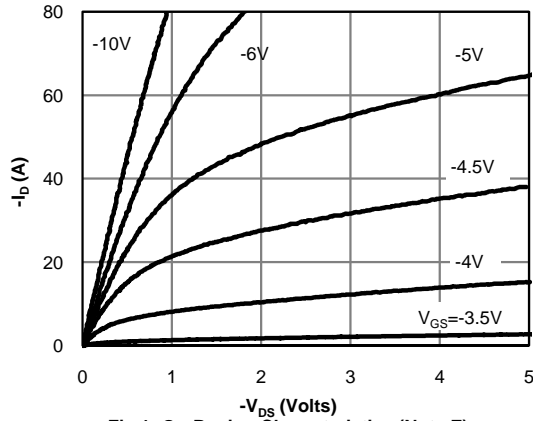


Figure 1: On-Region Characteristics (Note E)

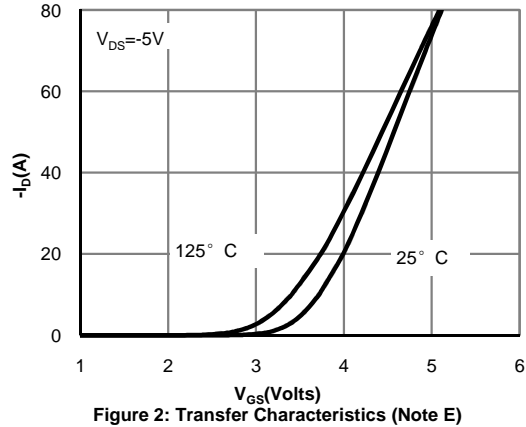


Figure 2: Transfer Characteristics (Note E)

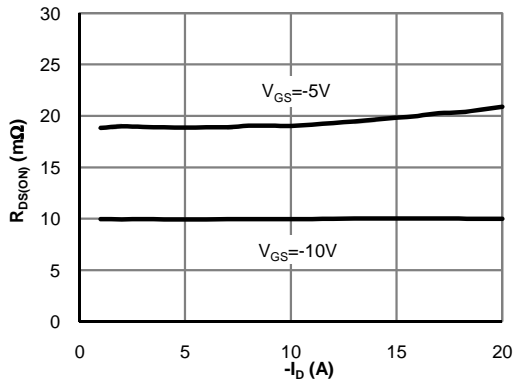


Figure 3: On-Resistance vs. Drain Current and Gate Voltage (Note E)

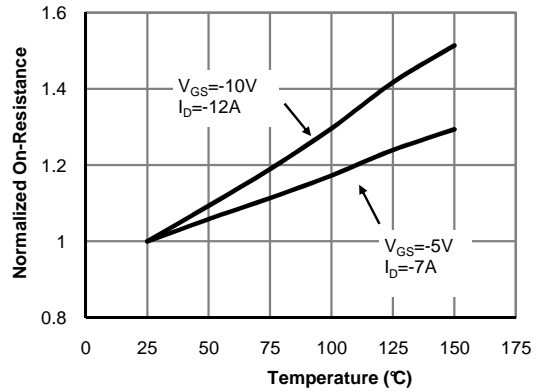


Figure 4: On-Resistance vs. Junction Temperature (Note E)

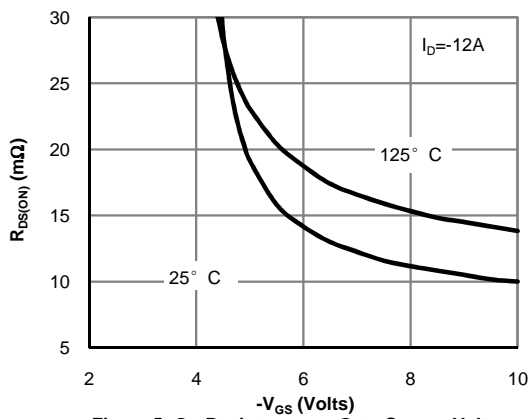


Figure 5: On-Resistance vs. Gate-Source Voltage (Note E)

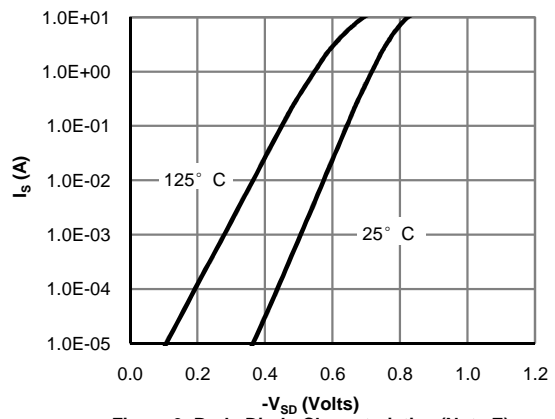


Figure 6: Body-Diode Characteristics (Note E)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

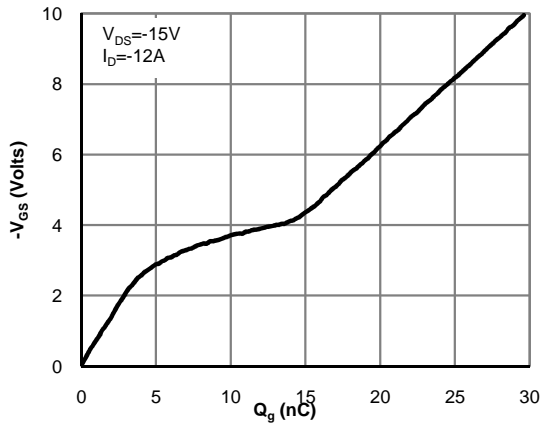


Figure 7: Gate-Charge Characteristics

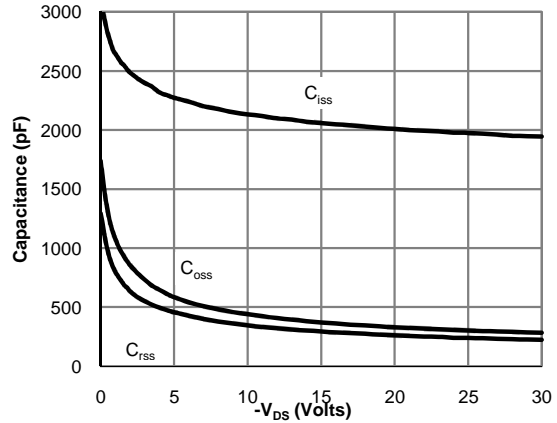


Figure 8: Capacitance Characteristics

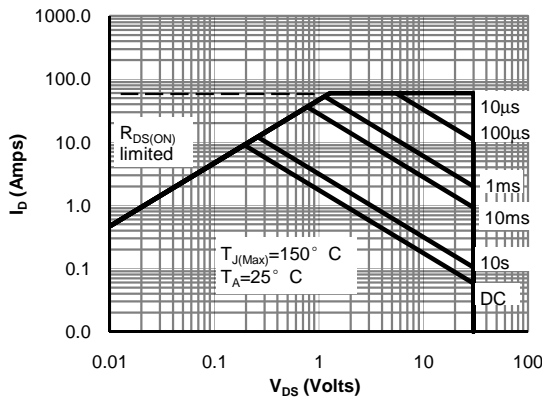


Figure 9: Maximum Forward Biased Safe Operating Area (Note F)

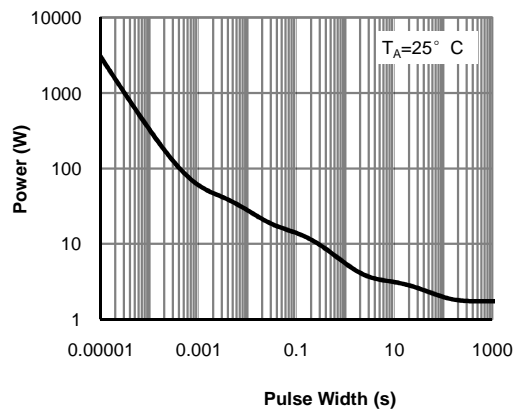


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note F)

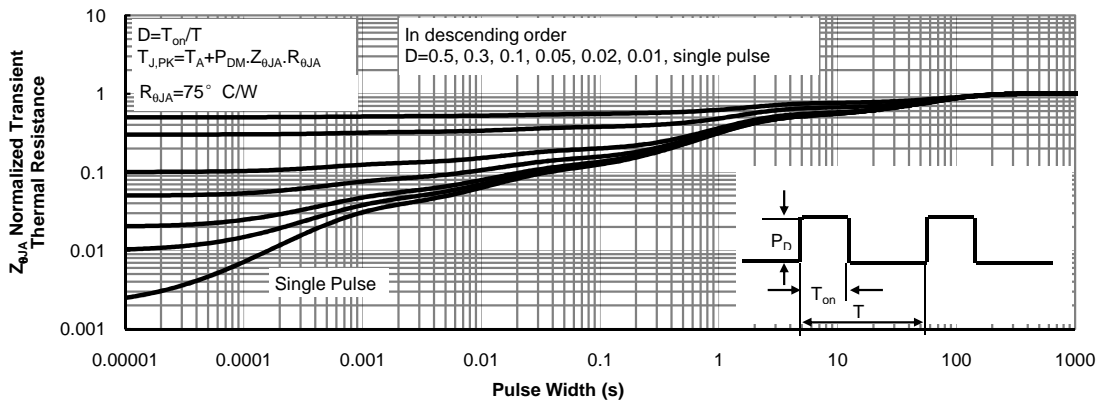
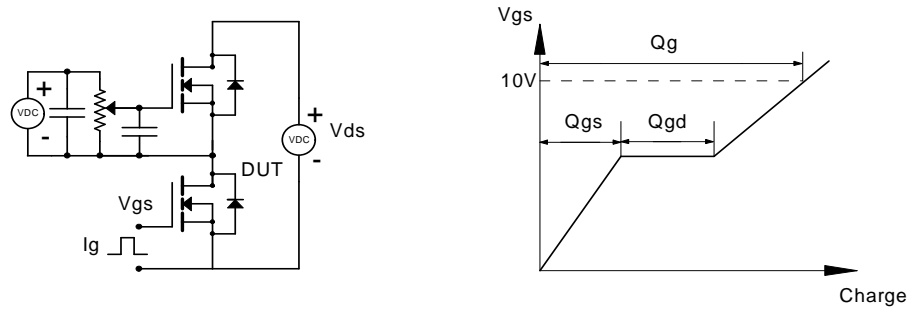
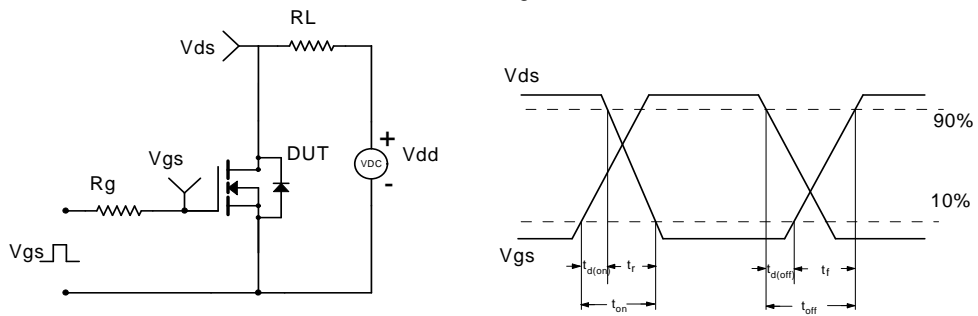


Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)

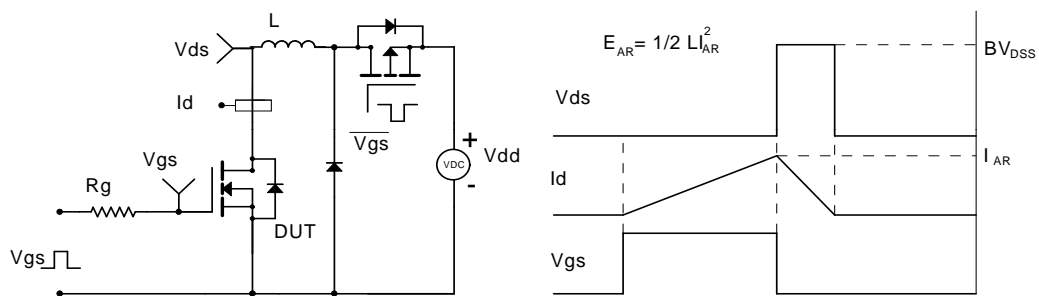
Gate Charge Test Circuit & Waveform



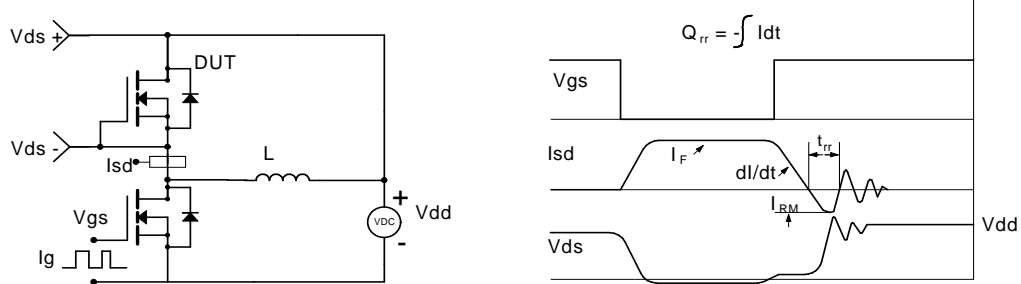
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching (UIS) Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms





Document No.	PD-00013
Version	F
Title	AO4407 Marking Description

SO-8 PACKAGE MARKING DESCRIPTION



Green product

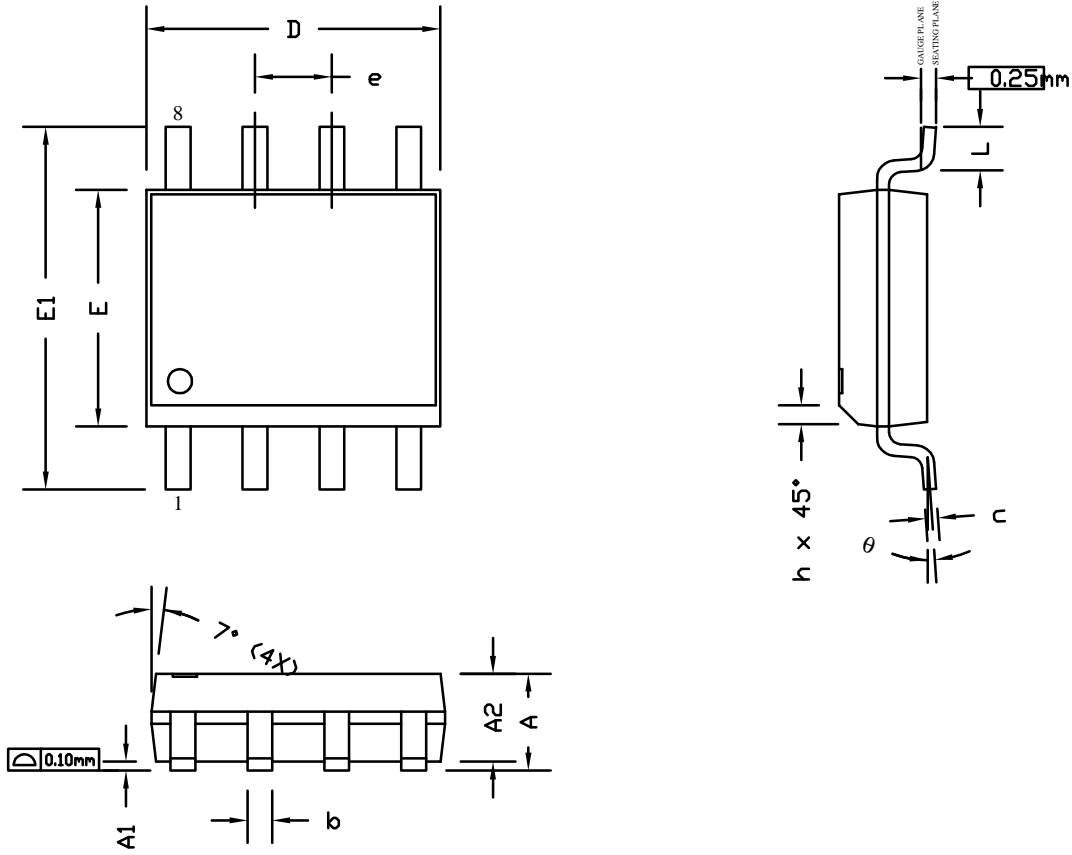
NOTE:	
LOGO	- AOS Logo
4407	- Part number code
F	- Fab code
A	- Assembly location code
Y	- Year code
W	- Week code
L&T	- Assembly lot code

PART NO.	DESCRIPTION	CODE
AO4407	Green product	4407
AO4407L	Green product	4407

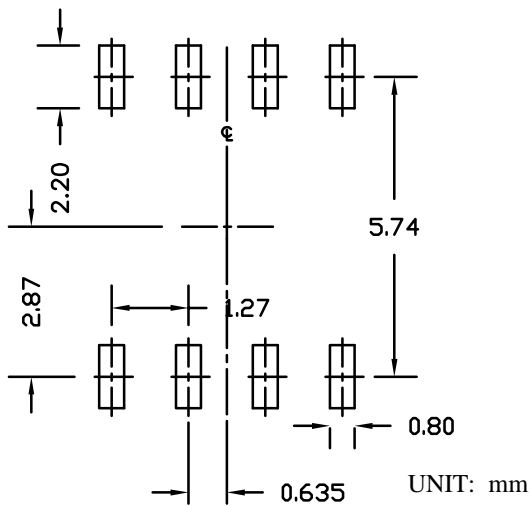


Document No.	PO-00004
Version	I

S08 PACKAGE OUTLINE



RECOMMENDED LAND PATTERN



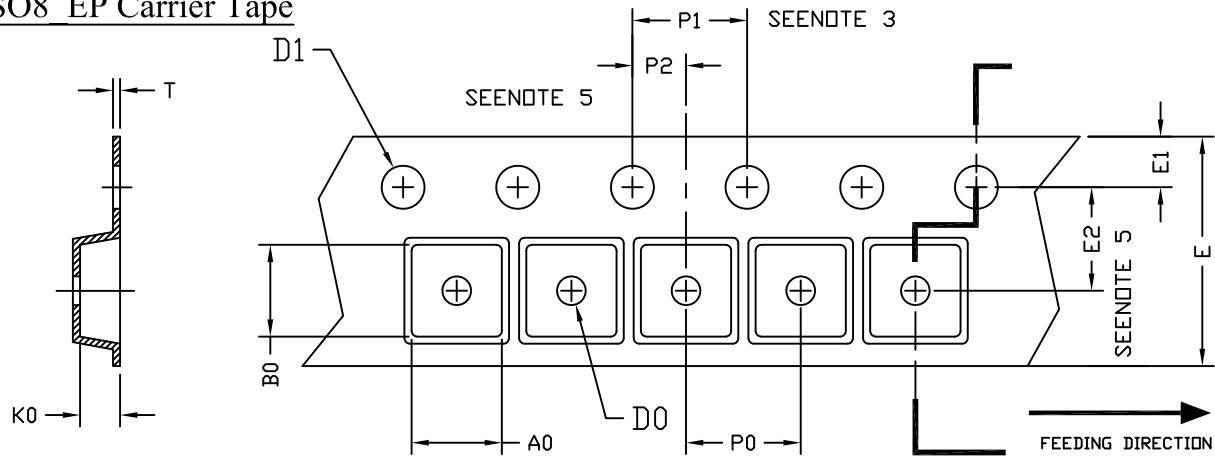
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	1.65	1.75	0.053	0.065	0.069
A1	0.10	0.15	0.25	0.004	0.006	0.010
A2	1.25	1.50	1.65	0.049	0.059	0.065
b	0.31	0.41	0.51	0.012	0.016	0.020
c	0.17	0.20	0.25	0.007	0.008	0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	3.80	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 MILLIMETERS.
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.



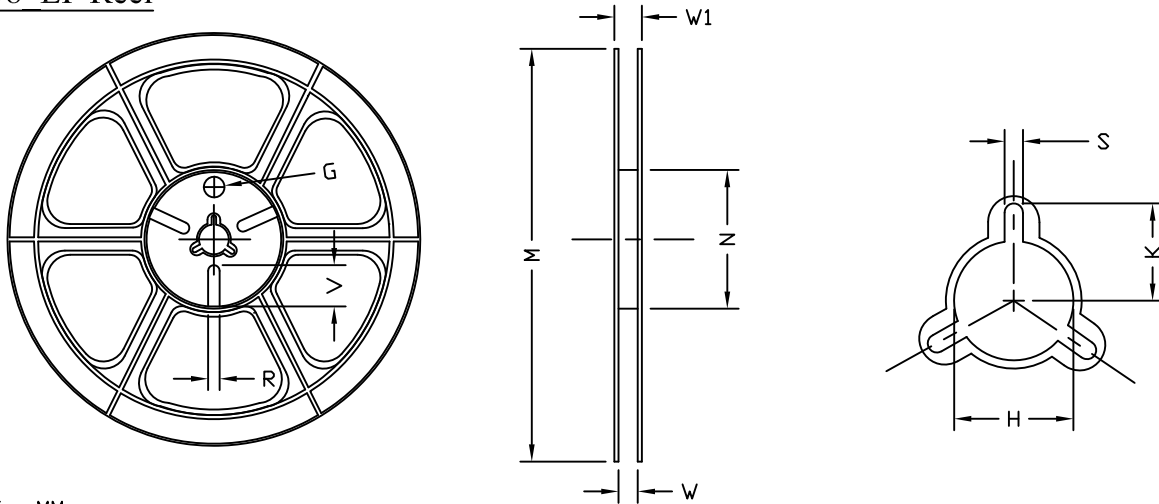
SO8/SO8 EP Carrier Tape



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



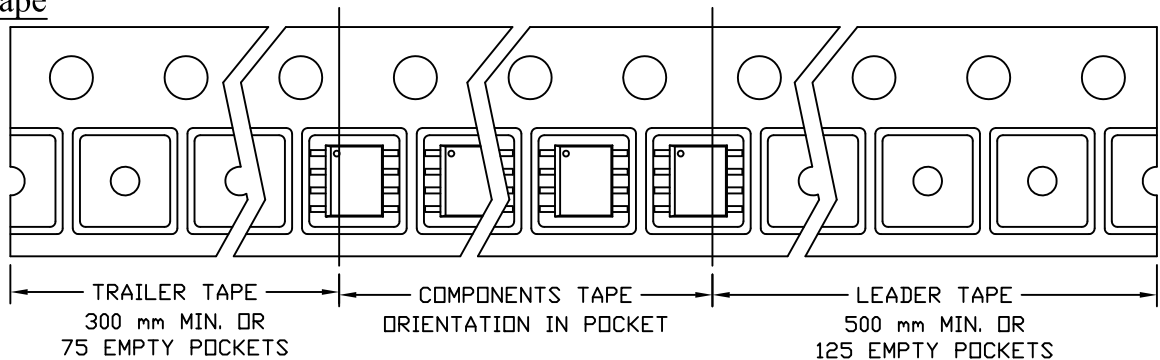
UNIT: MM

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





AOS Semiconductor Product Reliability Report

AO4407 / AO4407L, rev D

Plastic Encapsulated Device

ALPHA & OMEGA Semiconductor, Inc

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www.aosmd.com

Dec 27, 2005

This AOS product reliability report summarizes the qualification result for AO4407. 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 AO4407 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
- II. Package and Die information
- III. Environmental Stress Test Summary and Result
- IV. Reliability Evaluation
- V. Quality Assurance Information

I. Product Description:

The AO4407 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. Standard Product AO4407 is Pb-free (meets ROHS & Sony 259 specifications). AO4407L is a Green Product ordering option. AO4407 and AO4407L are electrically identical.

Absolute Maximum Ratings $T_A=25^\circ\text{C}$ unless otherwise noted				
Parameter		Symbol	Maximum	Units
Drain-Source Voltage		V_{DS}	-30	V
Gate-Source Voltage		V_{GS}	± 25	V
Continuous Drain Current	$T_A=25^\circ\text{C}$	I_D	-12	A
	$T_A=70^\circ\text{C}$		-10	
Pulsed Drain Current		I_{DM}	-60	
Power Dissipation	$T_A=25^\circ\text{C}$	P_D	3	W
	$T_A=70^\circ\text{C}$		2.1	
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	$T \leq 10\text{s}$	$R_{\theta JA}$	28	40	$^\circ\text{C/W}$
	Steady-State		54	75	$^\circ\text{C/W}$
Maximum Junction-to-Lead	Steady-State	$R_{\theta JL}$	21	30	$^\circ\text{C/W}$

II. Die / Package Information:

	AO4407	AO4407L (Green Compound)
Process	Standard sub-micron low voltage P channel process	Standard sub-micron low voltage P channel process
Package Type	8 leads SOIC	8 leads SOIC
Lead Frame	Ag with Solder Plate	Ag with Solder Plate
Die Attach	Silver-filled Epoxy	Silver-filled Epoxy
Bond wire	2 mils Au wire	2 mils Au wire
Mold Material	Epoxy resin with silica filler	Epoxy resin with silica filler
Filler % (Spherical/Flake)	90/10	100/0
Flammability Rating	UL-94 V-0	UL-94 V-0
Backside Metallization	Ti / Ni / Ag	Ti / Ni / Ag
Moisture Level	Up to Level 1 *	Up to Level 1*

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

III. Result of Reliability Stress for AO4407 (Standard) & AO4407L (Green)

Test Item	Test Condition	Time Point	Lot Attribution	Total Sample size	Number of Failures
Solder Reflow Precondition	Standard: 1hrPCT+3 cycle reflow@260°C Green: 168hr 85°C /85%RH +3 cycle reflow @260°C	0hr	Standard: 6 lots Green: 16 lots	3300 pcs	0
HTGB	Temp = 150°C, Vgs=100% of Vgsmax	168 / 500 hrs 1000 hrs	6 lots (Note A*)	492 pcs 77+5 pcs / lot	0
HTRB	Temp = 150°C, Vds=80% of Vdsmax	168 / 500 hrs 1000 hrs	6 lots (Note A*)	492 pcs 77+5 pcs / lot	0
HAST	130 +/- 2°C, 85%RH, 33.3 psi, Vgs = 80% of Vgs max	100 hrs	Standard: 6 lots Green: 13 lots (Note B**)	1045 pcs 50+5 pcs / lot	0
Pressure Pot	121°C, 15+/-1 PSIG, RH=100%	96 hrs	Standard: 5 lots Green: 16 lots (Note B**)	1155 pcs 50+5 pcs / lot	0
Temperature Cycle	-65°C to 150°C, air to air, 0.5hr per cycle	250 / 500 cycles	Standard: 5 lots Green: 15 lots (Note B**)	1100 pcs 50+5 pcs / lot	0

III. Result of Reliability Stress for AO4407 (Standard) & AO4407L (Green) Continues

DPA	Internal Vision Cross-section X-ray	NA	5 5 5	5 5 5	0
CSAM		NA	5	5	0
Bond Integrity	Room Temp 150°C bake 150°C bake	0hr 250hr 500hr	40 40 40	40 wires 40 wires 40 wires	0
Solderability	230°C	5 sec	15	15 leads	0
Die Shear	150°C	0hr	10	10	0

Note A: The HTGB and HTRB reliability data presents total of available AO4407 and AO4407L burn-in data up to the published date.

Note B: The pressure pot, temperature cycle and HAST reliability data for AO4407 and AO4407L comes from the AOS generic package qualification data.

IV. Reliability Evaluation

FIT rate (per billion): 7

MTTF = 16307 years

In general, 500 hrs of HTGB, 150 deg C accelerated stress testing is equivalent to 15 years of lifetime at 55 deg C operating conditions (by applying the Arrhenius equation with an activation energy of 0.7eV and 60% of upper confidence level on the failure rate calculation). AOS reliability group also routinely monitors the product reliability up to 1000 hr at and performs the necessary failure analysis on the units failed for reliability test(s).

The presentation of FIT rate for the individual product reliability is restricted by the actual burn-in sample size of the selected product (AO3401). Failure Rate Determination is based on JEDEC Standard JESD 85. FIT means one failure per billion hours.

$$\begin{aligned} \text{Failure Rate} &= \text{Chi}^2 \times 10^9 / [2 (N) (H) (Af)] \\ &= 1.83 \times 10^9 / [2 (3 \times 164) (168) (258) + 2 (164) (500)(258) + 2 (2 \times 164) (1000) (258)] \\ &= 7 \end{aligned}$$

$$\text{MTTF} = 10^9 / \text{FIT} = 1.42 \times 10^8 \text{hrs} = 16307 \text{ years}$$

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°C)

Acceleration Factor [**Af**] = $\text{Exp} [E_a / k (1/T_j u - 1/T_j s)]$

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 10⁻⁵e V / K



V. Quality Assurance Information

Acceptable Quality Level for outgoing inspection: **0.1%** for electrical and visual.

Guaranteed Outgoing Defect Rate: **< 25 ppm**

Quality Sample Plan: conform to **Mil-Std-105D**

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[IRF40H233XTMA1](#) [STU5N65M6](#) [DMN6022SSD-13](#) [DMN13M9UCA6-7](#) [DMTH10H4M6SPS-13](#) [IPS60R360PFD7SAKMA1](#)
[DMN2990UFB-7B](#) [SSM3K35CT,L3F](#) [IPLK60R1K0PFD7ATMA1](#) [2N7002W-G](#) [MCAC30N06Y-TP](#) [IPWS65R035CFD7AXKSA1](#)
[MCQ7328-TP](#) [SSM3J143TU,LXHF](#) [DMN12M3UCA6-7](#) [PJMF280N65E1_T0_00201](#) [PJMF380N65E1_T0_00201](#)
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