ALPHA & OMEGA SEMICONDUCTOR

AOT460
N-Channel Enhancement Mode Field Effect Transistor

General Description

The AOT460/L uses advanced trench technology and design to provide excellent $R_{DS(ON)}$ with low gate charge. This device is suitable for use in UPS, high current switching applications.
AOT460and AOT460L are electrically identical.

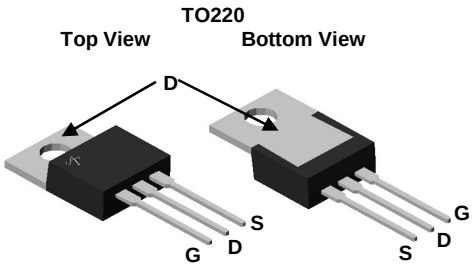
-RoHS Compliant
-Halogen Free

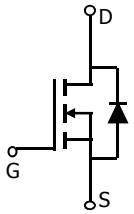
Features

V_{DS} (V) = 60V
I_D = 85 A (V_{GS} = 10V)
$R_{DS(ON)}$ < 7.5mΩ (V_{GS} = 10V)

100% UIS Tested!

TO220





Absolute Maximum Ratings T_A=25°C unless otherwise noted

Parameter		Symbol	Maximum	Units
Drain-Source Voltage		V_{DS}	60	V
Gate-Source Voltage		V_{GS}	±20	V
Continuous Drain Current[G]	T_C=25°C	I_D	85	A
	T_C=100°C		66	
Pulsed Drain Current [C]		I_{DM}	340	
Avalanche Current [C]		I_{AR}	80	A
Repetitive avalanche energy L=0.1mH [C]		E_{AR}	320	mJ
Power Dissipation [B]	T_C=25°C	P_D	268	W
	T_C=100°C		134	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 175	°C

Thermal Characteristics

Parameter		Symbol	Typ	Max	Units
Maximum Junction-to-Ambient [A]	Steady-State	$R_{\theta JA}$	45	60	°C/W
Maximum Junction-to-Case [B]	Steady-State	$R_{\theta JC}$	0.45	0.56	°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=250uA, V_{GS}=0V	60			V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS}=60V, V_{GS}=0V			10	µA
		T_J=55°C			50	
I_{GSS}	Gate-Body leakage current	V_{DS}=0V, V_{GS}=±20V			100	nA
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS}=V_{GS}, I_D=250µA	2	2.95	4	V
$I_{D(ON)}$	On state drain current	V_{GS}=10V, V_{DS}=5V	340			A
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS}=10V, I_D=30A		6.3	7.5	mΩ
		T_J=125°C		10.5	13	
g_{FS}	Transconductance	V_{DS}=5V, I_D=30A		90		S
V_{SD}	Diode Forward Voltage	I_S=1A, V_{GS}=0V		0.7	1	V
I_S	Maximum Body-Diode Continuous Current [G]				85	A
DYNAMIC PARAMETERS						
C_{iss}	Input Capacitance	V_{GS}=0V, V_{DS}=30V, f=1MHz		3800	4560	pF
C_{oss}	Output Capacitance			430		pF
C_{rss}	Reverse Transfer Capacitance			190		pF
R_g	Gate resistance	V_{GS}=0V, V_{DS}=0V, f=1MHz		1.5	2.3	Ω
SWITCHING PARAMETERS						
Q_g(10V)	Total Gate Charge	V_{GS}=10V, V_{DS}=30V, I_D=30A		68	88	nC
Q_g(4.5V)	Total Gate Charge			33		nC
Q_{gs}	Gate Source Charge			15		nC
Q_{gd}	Gate Drain Charge			19		nC
$t_{D(on)}$	Turn-On DelayTime	V_{GS}=10V, V_{DS}=30V, R_L=1Ω, R_{GEN}=3Ω		18		ns
t_r	Turn-On Rise Time			35		ns
$t_{D(off)}$	Turn-Off DelayTime			44		ns
t_f	Turn-Off Fall Time			23		ns
t_{rr}	Body Diode Reverse Recovery Time	I_F=30A, dI/dt=100A/µs		53	64	ns
Q_{rr}	Body Diode Reverse Recovery Charge	I_F=30A, dI/dt=100A/µs		98		nC

A: The value of $R_{\theta JA}$ is measured with the device in a still air environment with T_A=25° C.
B. The power dissipation P_D is based on $T_{J(MAX)}$=175° C, using junction-to-case thermal resistance, and is more useful in setting the upper dissipation limit for cases where additional heatsinking is used.
C: Repetitive rating, pulse width limited by junction temperature $T_{J(MAX)}$=175° C.
D. The $R_{\theta JA}$ is the sum of the thermal impedence from junction to case $R_{\theta JC}$ and case to ambient.
E. The static characteristics in Figures 1 to 6 are obtained using <300 µs pulses, duty cycle 0.5% max.
F. These curves are based on the junction-to-case thermal impedence which is measured with the device mounted to a large heatsink, assuming a maximum junction temperature of $T_{J(MAX)}$=175° C.
G. The maximum current rating is limited by bond-wires.
Rev1: Jan. 2009

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

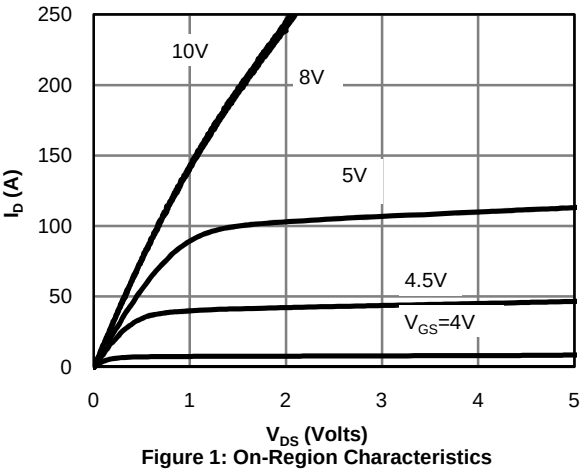


Figure 1: On-Region Characteristics

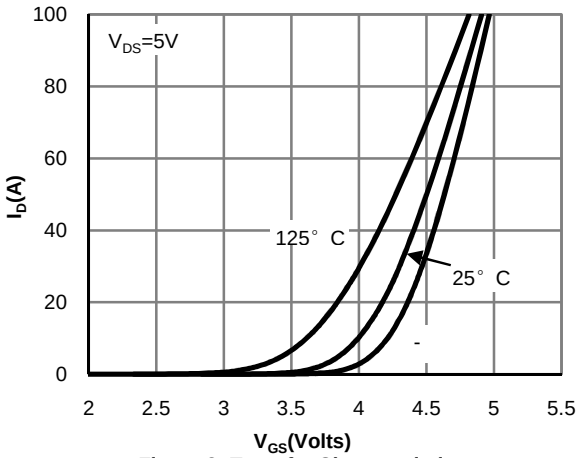


Figure 2: Transfer Characteristics

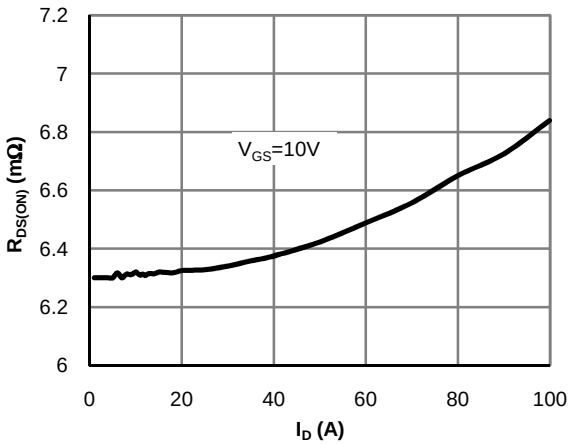


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

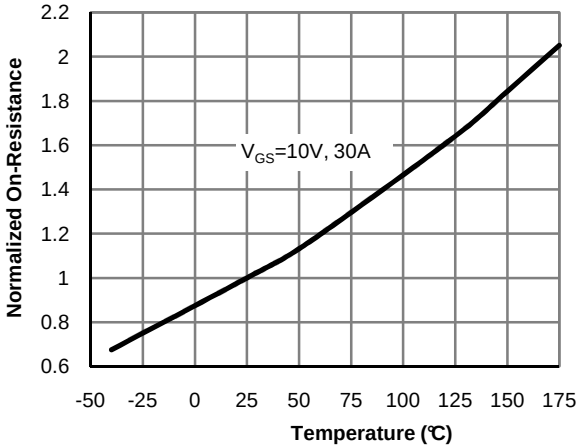


Figure 4: On-Resistance vs. Junction Temperature

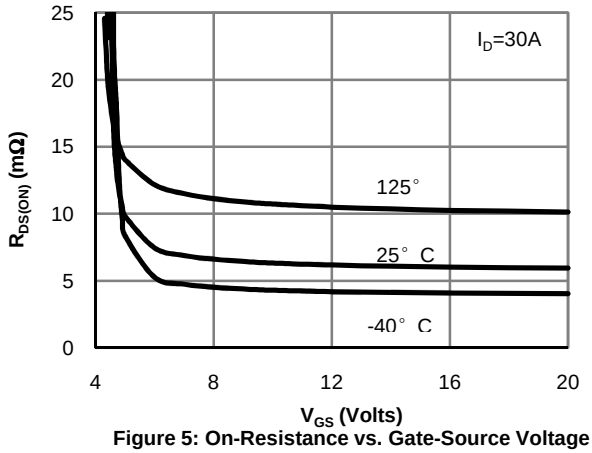


Figure 5: On-Resistance vs. Gate-Source Voltage

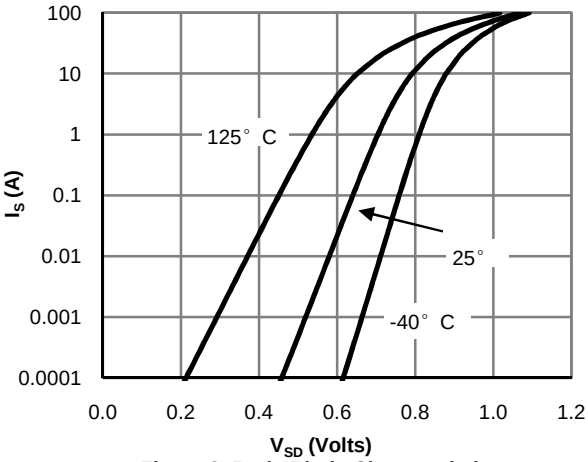


Figure 6: Body-Diode Characteristics

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

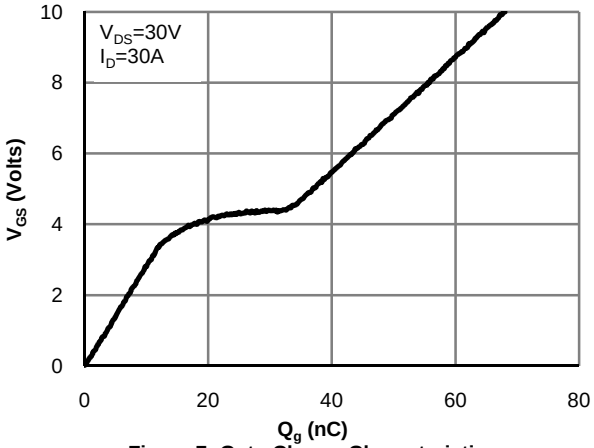


Figure 7: Gate-Charge Characteristics

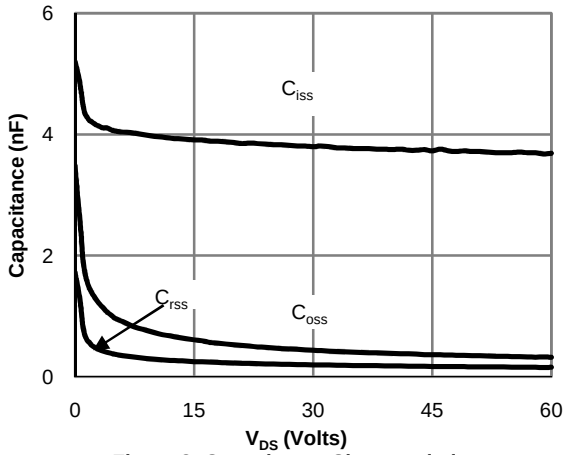


Figure 8: Capacitance Characteristics

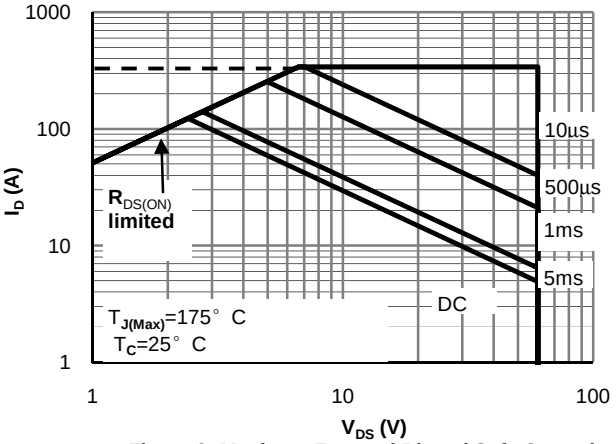


Figure 9: Maximun Forward Biased Safe Operating Area (Note F)

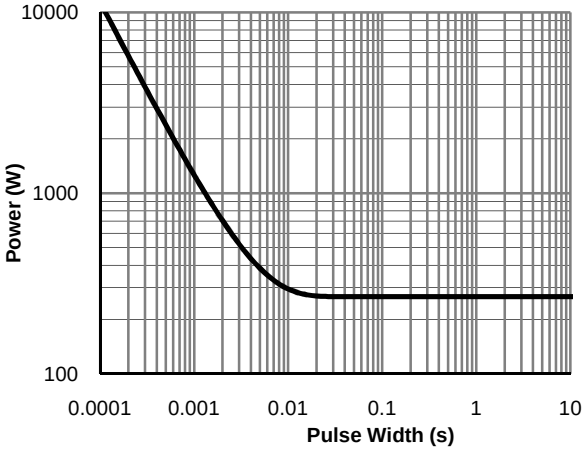


Figure 10: Single Pulse Power Rating Junction-to-Case (Note F)

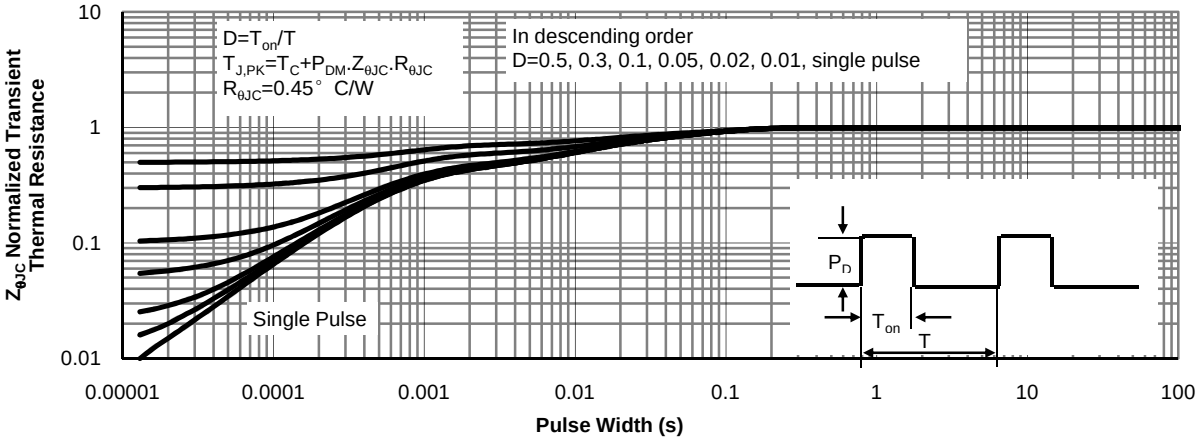


Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

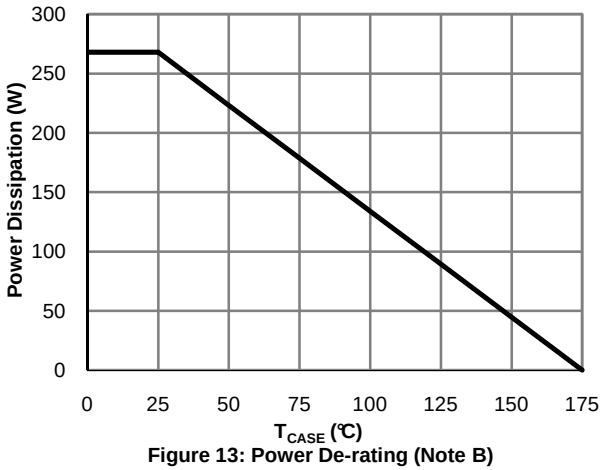


Figure 13: Power De-rating (Note B)

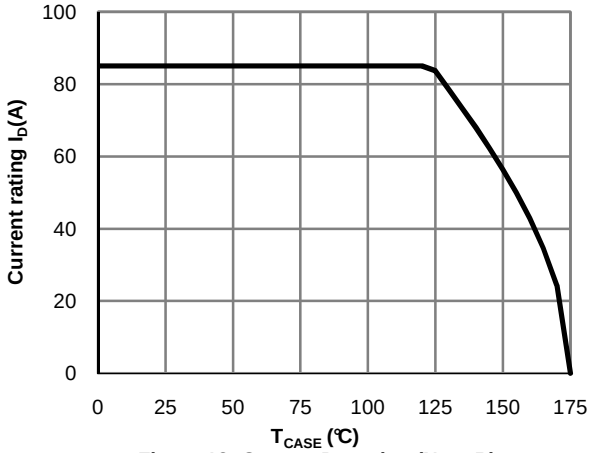


Figure 12: Current De-rating (Note B)

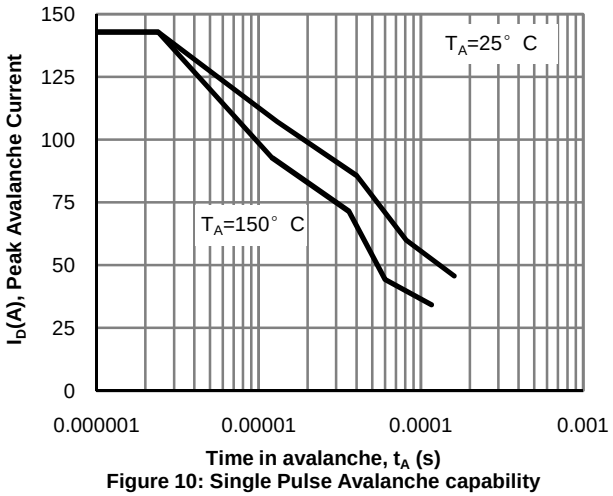
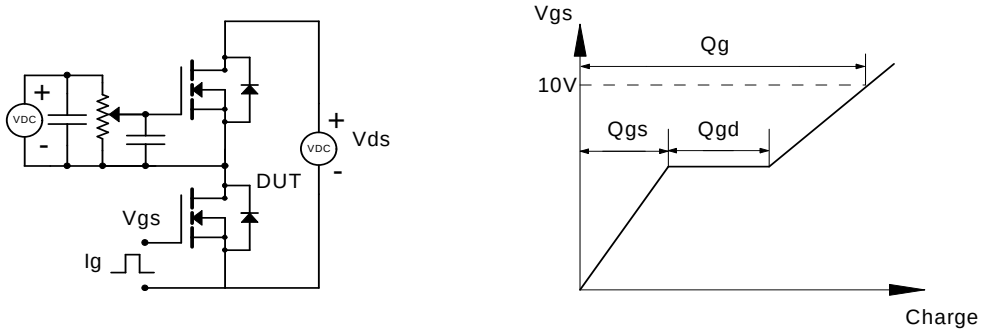
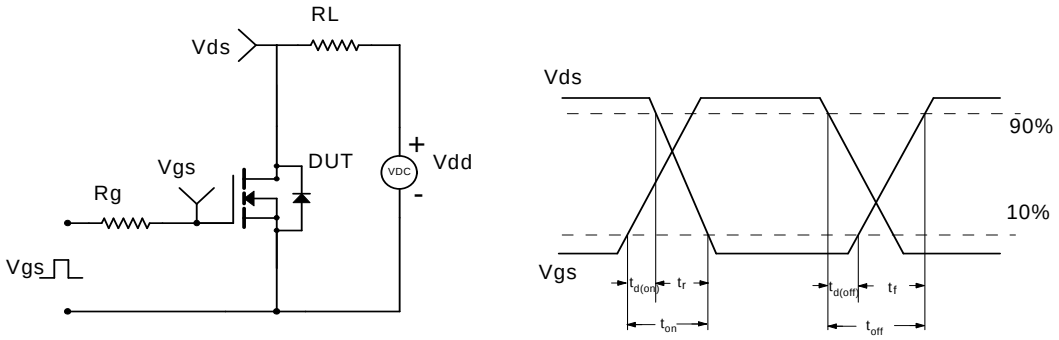


Figure 10: Single Pulse Avalanche capability

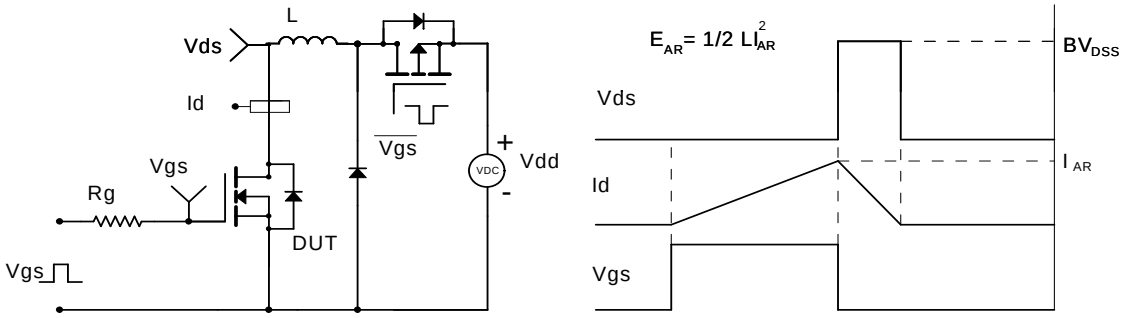
Gate Charge Test Circuit & Waveform



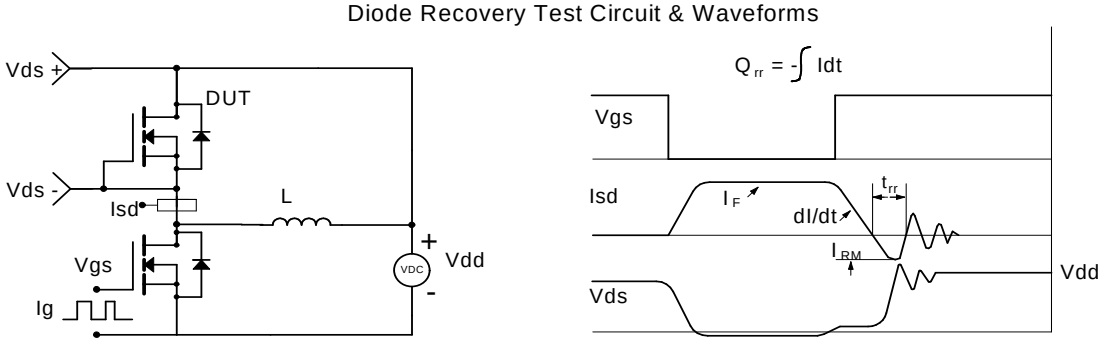
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching (UIS) Test Circuit & Waveforms



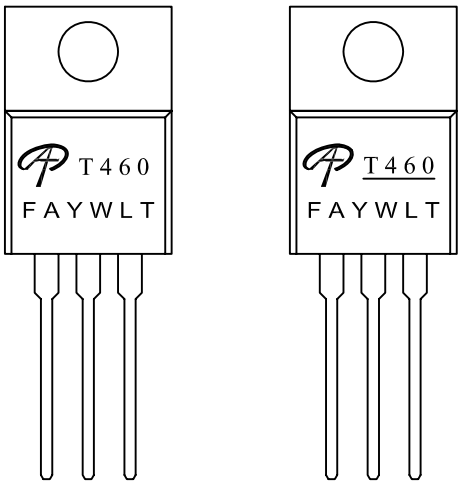
Diode Recovery Test Circuit & Waveforms



ALPHA & OMEGA SEMICONDUCTOR

Document No.	PD-00807
Version	A
Title	AOT460 Marking Description

D2PAK(TO-220) PACKAGE MARKING DESCRIPTION



Standard product Green product

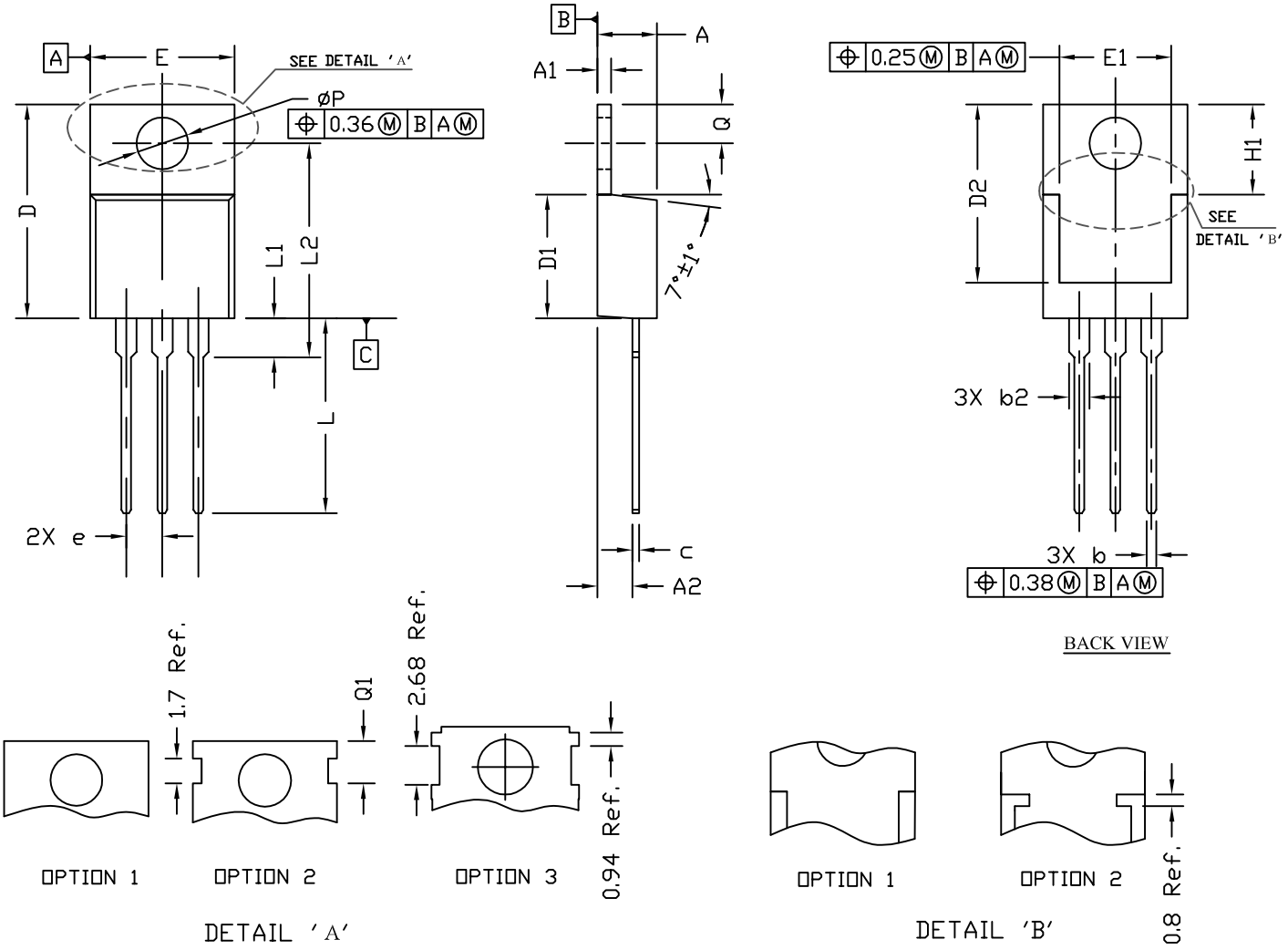
NOTE:
LOGO - AOS Logo
T460 - Part number code
F - Fab code
A - Assembly location code
Y - Year code
W - Week code
L&T - Assembly lot code

PART NO.	DESCRIPTION	CODE
AOT460	Standard product	T460
AOT460L	Green product	T460

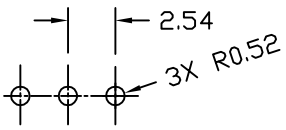
ALPHA & OMEGA SEMICONDUCTOR

Document No.	PO-00015
Version	L

TO220 PACKAGE OUTLINE



RECOMMENDATION OF HOLE PATTERN



UNIT: mm

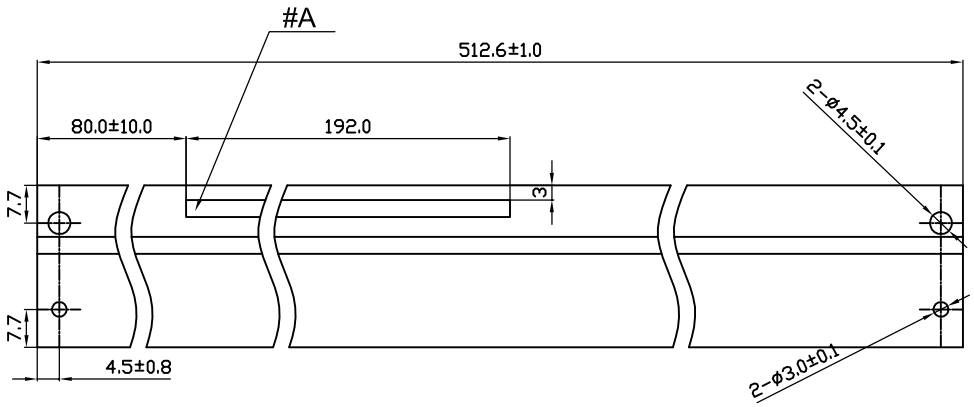
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	4.30	4.45	4.72	0.169	0.175	0.186
A1	1.15	1.27	1.40	0.045	0.050	0.055
A2	2.20	2.67	2.90	0.087	0.105	0.114
b	0.69	0.81	0.95	0.027	0.032	0.037
b2	1.17	1.37	1.45	0.046	0.050	0.068
c	0.36	0.38	0.60	0.014	0.015	0.024
D	14.50	15.44	15.80	0.571	0.608	0.622
D1	8.59	9.14	9.65	0.338	0.360	0.380
D2	11.43	11.73	12.48	0.450	0.462	0.491
e	2.54 BSC			0.100 BSC.		
E	9.66	10.03	10.54	0.380	0.395	0.415
E1	6.22	---	---	0.245	---	---
H1	6.10	6.30	6.50	0.240	0.248	0.256
L	12.27	12.82	14.27	0.483	0.505	0.562
L1	2.47	---	3.90	0.097	---	0.154
L2	---	---	16.70	---	---	0.657
Q	2.59	2.74	2.89	0.102	0.108	0.114
øP	3.50	3.84	3.89	0.138	0.151	0.153
Q1	2.70	---	2.90	0.106	---	0.114

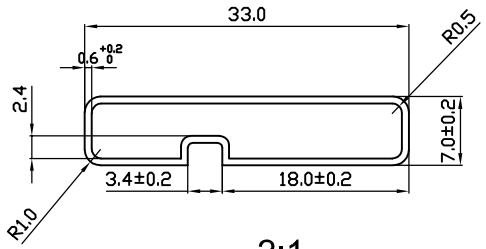
NOTE
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS. MOLD FLASH SHOULD BE LESS THAN 6 MIL.
2. TOLERANCE 0.100 MILLIMETERS UNLESS OTHERWISE SPECIFIED.
3. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.

ALPHA & OMEGA SEMICONDUCTOR

REV.	DATE	DESCRIPTION	DRG.
A		NEW ISSUE	

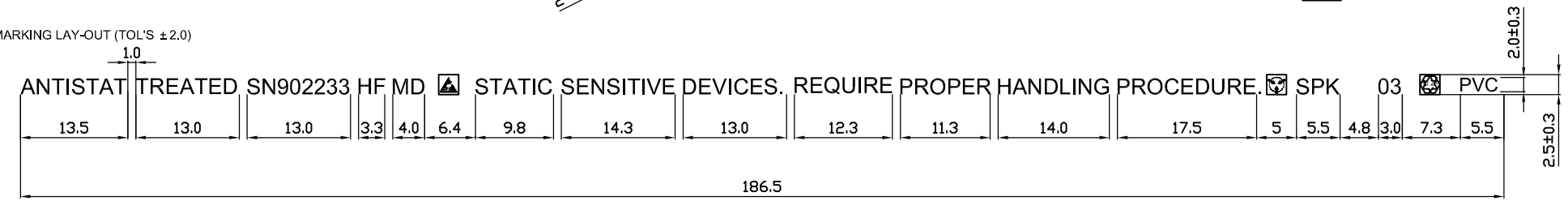
TO220/TO262 PLASTIC TUBE DRAWING





2:1

#A MARKING LAY-OUT (TOL'S ±2.0)



2:1

NOTE

1. TUBE
   - MATERIAL : P.V.C
   - COLOR : TRANSPARENCY, RED, YELLOW
   - MARKING #A : 6 MONTHS, BLACK COLOR
     LETTER STYLE : Arial
   - CAMBAR : 1.5 MAX
2. PIN
   - COLOR : GREEN (ONE PIN MUST BE INSERTED IN LEFT-SIDE OF " ANTISTATIC~" AND ANOTHER PIN IS FREE.)
3. ALL UNSPECIFICATED SPECIFICATIONS FOLLOW TUBE GENERAL SPEC.
   UNSPECIFICATED TOLERANCE ± 0.2
4. PACKING Q'TY :

PKG	Q'TY(PCS)
TO220/ TO262	50

ALPHA & OMEGA SEMICONDUCTOR		TITLE: TO220/TO262 TUBE DRAWING	
DRAWN BY	SIGNATURE		
APPROVED BY	SIGNATURE	UNIT: MM	PAGE: 1 OF 1
SCALE: N.T.S.	PROJECTION	DRAWING NUMBER: TR-00060	VENDOR CODE: N / REV.: B

AOS Semiconductor
Product Reliability Report

AOT460/AOT460L, rev A

Plastic Encapsulated Device

ALPHA & OMEGA Semiconductor, Inc

495 Mercury Drive
Sunnyvale, CA 94085
U.S.

Tel: (408) 830-9742 **www.aosmd.com**

ALPHA & OMEGA SEMICONDUCTOR

This AOS product reliability report summarizes the qualification result for AOT460. 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 AOT460 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 AOT460 uses advanced trench technology and design to provide excellent $R_{DS(ON)}$ with low gate charge. This device is suitable for use in UPS, high current switching applications. Standard Product AOT460 is Pb-free (meets ROHS & Sony 259 specifications). AOT460L is a Green Product ordering option. AOT460 and AOT460L are electrically identical.

Absolute Maximum Ratings T_A=25°C unless otherwise noted				
Parameter		**Symbol**	**Maximum**	**Units**
Drain-Source Voltage		V_{DS}	60	V
Gate-Source Voltage		V_{GS}	±20	V
Continuous Drain Current	T_A=25°C	I_D	85	A
	T_A=100°C		85	
Pulsed Drain Current		I_{DM}	250	
Avalanche Current		I_{AR}	80	A
Power Dissipation	T_A=25°C	P_D	268	W
	T_A=100°C		134	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 175	°C

Thermal Characteristics					
Parameter		**Symbol**	**Typ**	**Max**	**Units**
Maximum Junction-to-Ambient	Steady-State	$R_{\theta JA}$	45	60	°C/W
Maximum Junction-to-Case	Steady-State	$R_{\theta JC}$	0.45	0.56	°C/W

ALPHA & OMEGA SEMICONDUCTOR

II. Die / Package Information:

	AOT460	AOT460L (Green Compound)
Process	Standard sub-micron low voltage N channel process	Standard sub-micron low voltage N channel process
Package Type	3 leads TO220	3 leads TO220
Lead Frame	Copper	Copper
Die Attach	Soft solder	Soft solder
Bond wire	Al 5&15mils	Al 5&15mils
Mold Material	Soft solder	Soft solder
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 AOT460 (Standard) & AOT460L (Green)

Test Item	Test Condition	Time Point	Lot Attribution	Total Sample size	Number of Failures
Solder Reflow Precondition	**Standard: 1hr PCT+3 cycle reflow@260°c** **Green: 168hr 85°c /85%RH +3 cycle reflow@260°c**	**0hr**	**Standard: 24 lots** **Green: 1 lot**	**3520pcs**	**0**
HTGB	**Temp = 150°c , Vgs=100% of Vgsmax**	**168 / 500 hrs** **1000 hrs**	**1 lots** **(Note A*)**	**492pcs** **77+5 pcs / lot**	**0**
HTRB	**Temp = 150°c , Vds=80% of Vdsmax**	**168 / 500 hrs** **1000 hrs**	**1 lots** **(Note A*)**	**492pcs** **77+5 pcs / lot**	**0**
HAST	**130 +/- 2°c , 85%RH, 33.3 psi, Vgs = 80% of Vgs max**	**100 hrs**	**Standard : 21 lots** **Green: 1 lot** **(Note B**)**	**1210pcs** **50+5 pcs / lot**	**0**
Pressure Pot	**121°c , 15+/-1 PSIG, RH=100%**	**96 hrs**	**Standard : 24 lots** **Green: 1 lot** **(Note B**)**	**1375pcs** **50+5 pcs / lot**	**0**
Temperature Cycle	**-65°c to 150°c , air to air**	**250 / 500 cycles**	**Standard : 16 lots** **Green: 1 lot** **(Note B**)**	**935pcs** **50+5 pcs / lot**	**0**

III. Result of Reliability Stress for AOT460 (Standard) & AOT460L (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 AOT460 and AOT460L burn-in data up to the published date.
Note B: The pressure pot, temperature cycle and HAST reliability data for AOT460 and AOT460L comes from the AOS generic package qualification data.

IV. Reliability Evaluation

FIT rate (per billion): 42.7
MTTF = 2367.5years

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 (AOT460). 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 (164) (500) (258)**]** = 42.7
MTTF = 10^9 / FIT = 2.50×10^8hrs = 2367.5years

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**] = **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, 8.617164×10^{-5}e 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**