ALPHA & OMEGA SEMICONDUCTOR

# AOD4184A

## 40V N-Channel MOSFET

### General Description

The AOD4184A combines advanced trench MOSFET technology with a low resistance package to provide extremely low $R_{DS(ON)}$. This device is well suited for high current load applications.

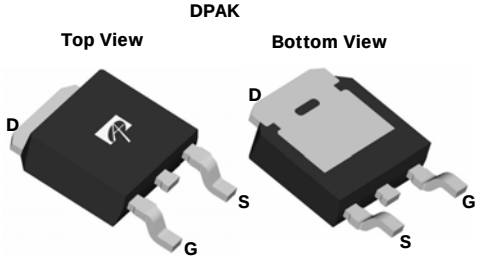
### Product Summary

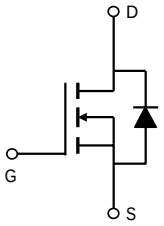
| | |
|---|---|
| $V_{DS}$ | 40V |
| $I_D$ (at $V_{GS}$=10V) | 50A |
| $R_{DS(ON)}$ (at $V_{GS}$=10V) | < 7mΩ |
| $R_{DS(ON)}$ (at $V_{GS}$ = 4.5V) | < 9.5mΩ |

**100% UIS Tested**
**100% Rg Tested**

Green Product

**TO252**
**DPAK**




**Absolute Maximum Ratings $T_A$=25°C unless otherwise noted**

| Parameter | | Symbol | Maximum | Units |
|---|---|---|---|---|
| Drain-Source Voltage | | $V_{DS}$ | 40 | V |
| Gate-Source Voltage | | $V_{GS}$ | ±20 | V |
| Continuous Drain Current [G] | $T_C$=25°C | $I_D$ | 50 | A |
| | $T_C$=100°C | | 40 | |
| Pulsed Drain Current [C] | | $I_{DM}$ | 120 | |
| Continuous Drain Current | $T_A$=25°C | $I_{DSM}$ | 13 | A |
| | $T_A$=70°C | | 10 | |
| Avalanche Current [C] | | $I_{AS}$, $I_{AR}$ | 35 | A |
| Avalanche energy L=0.1mH [C] | | $E_{AS}$, $E_{AR}$ | 61 | mJ |
| Power Dissipation [B] | $T_C$=25°C | $P_D$ | 50 | W |
| | $T_C$=100°C | | 25 | |
| Power Dissipation [A] | $T_A$=25°C | $P_{DSM}$ | 2.3 | W |
| | $T_A$=70°C | | 1.5 | |
| 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] | t ≤ 10s | $R_{\theta JA}$ | 18 | 22 | °C/W |
| Maximum Junction-to-Ambient [A D] | Steady-State | | 44 | 55 | °C/W |
| Maximum Junction-to-Case | Steady-State | $R_{\theta JC}$ | 2.4 | 3 | °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 | 40 | | | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$=40V, $V_{GS}$=0V | | | 1 | µA |
| | | $T_J$=55°C | | | 5 | |
| $I_{GSS}$ | 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 | 1.7 | 2.1 | 2.6 | V |
| $I_{D(ON)}$ | On state drain current | $V_{GS}$=10V, $V_{DS}$=5V | 120 | | | A |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}$=10V, $I_D$=20A | | 5.8 | 7 | mΩ |
| | | $T_J$=125°C | | 9.6 | 12 | |
| | | $V_{GS}$=4.5V, $I_D$=15A | | 7.6 | 9.5 | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$=5V, $I_D$=5A | | 37 | | S |
| $V_{SD}$ | Diode Forward Voltage | $I_S$=1A,$V_{GS}$=0V | | 0.7 | 1 | V |
| $I_S$ | Maximum Body-Diode Continuous Current | | | | 20 | A |
| **DYNAMIC PARAMETERS** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{GS}$=0V, $V_{DS}$=20V, f=1MHz | 1200 | 1500 | 1800 | pF |
| $C_{oss}$ | Output Capacitance | | 150 | 215 | 280 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | 80 | 135 | 190 | pF |
| $R_g$ | Gate resistance | $V_{GS}$=0V, $V_{DS}$=0V, f=1MHz | 2 | 3.5 | 5 | Ω |
| **SWITCHING PARAMETERS** | | | | | | |
| $Q_g$(10V) | Total Gate Charge | $V_{GS}$=10V, $V_{DS}$=20V, $I_D$=20A | 21 | 27 | 33 | nC |
| $Q_g$(4.5V) | Total Gate Charge | | 10 | 14 | 17 | nC |
| $Q_{gs}$ | Gate Source Charge | | 3 | 5 | 6 | nC |
| $Q_{gd}$ | Gate Drain Charge | | 3 | 6 | 9 | nC |
| $t_{D(on)}$ | Turn-On DelayTime | $V_{GS}$=10V, $V_{DS}$=20V, $R_L$=1Ω, $R_{GEN}$=3Ω | | 6 | | ns |
| $t_r$ | Turn-On Rise Time | | | 17 | | ns |
| $t_{D(off)}$ | Turn-Off DelayTime | | | 30 | | ns |
| $t_f$ | Turn-Off Fall Time | | | 17 | | ns |
| $t_{rr}$ | Body Diode Reverse Recovery Time | $I_F$=20A, dI/dt=100A/µs | 20 | 29 | 38 | ns |
| $Q_{rr}$ | Body Diode Reverse Recovery Charge | $I_F$=20A, dI/dt=100A/µs | 18 | 26 | 34 | nC |

A. The value of $R_{\theta JA}$ is measured with the device mounted on 1in$^2$ FR-4 board with 2oz. Copper, in a still air environment with $T_A$ =25°C. The Power dissipation $P_{DSM}$ is based on $R_{\theta JA}$ and the maximum allowed junction temperature of 150°C. The value in any given application depends on the user's specific board design, and the maximum temperature of 175°C may be used if the PCB allows it.

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. Ratings are based on low frequency and duty cycles to keep initial $T_J$ =25°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 <300µs 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. The SOA curve provides a single pulse rating.

G. The maximum current rating is package limited.

H. 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.

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

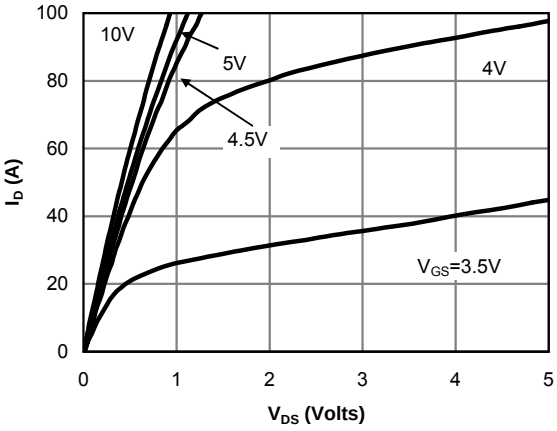



**Fig 1: On-Region Characteristics (Note E)**

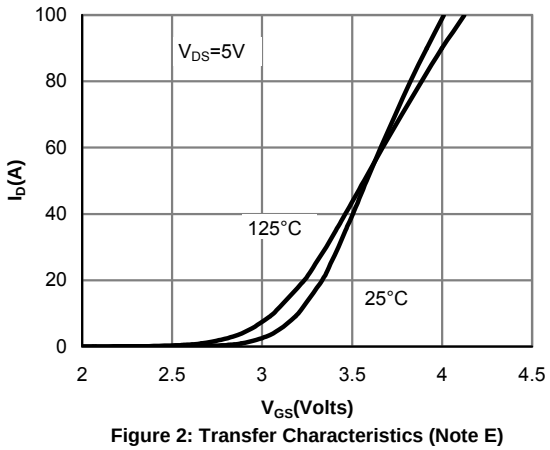



**Figure 2: Transfer Characteristics (Note E)**

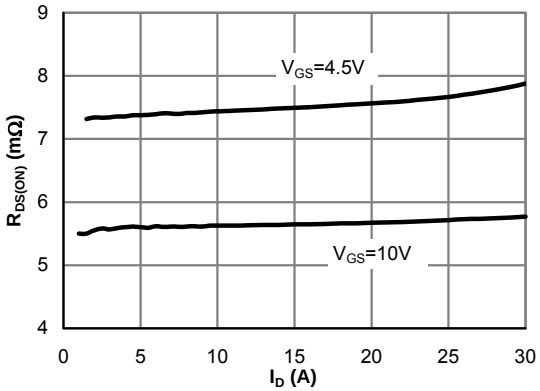



**Figure 3: On-Resistance vs. Drain Current and Gate Voltage (Note E)**

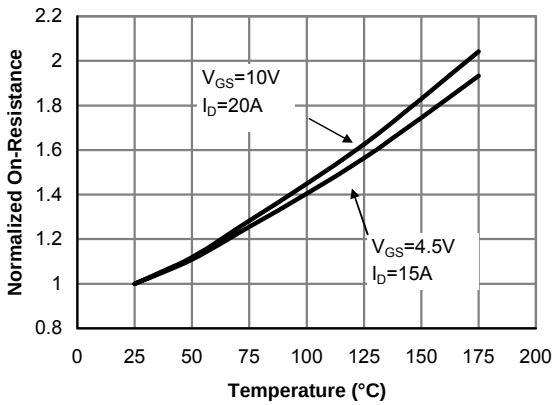



**Figure 4: On-Resistance vs. Junction Temperature (Note E)**

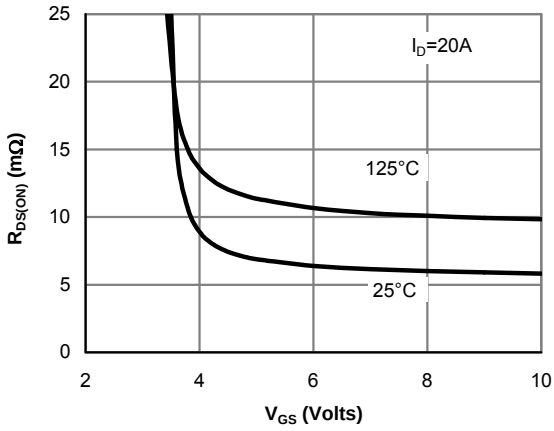



**Figure 5: On-Resistance vs. Gate-Source Voltage (Note E)**

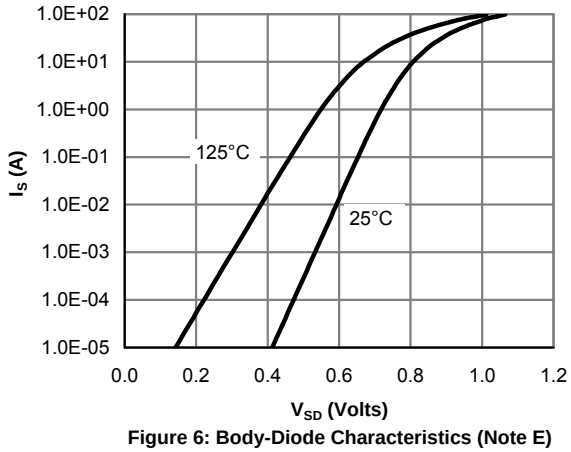



**Figure 6: Body-Diode Characteristics (Note E)**

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

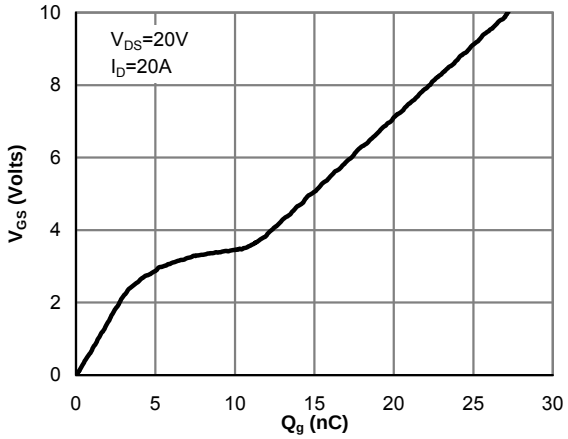



**Figure 7: Gate-Charge Characteristics**

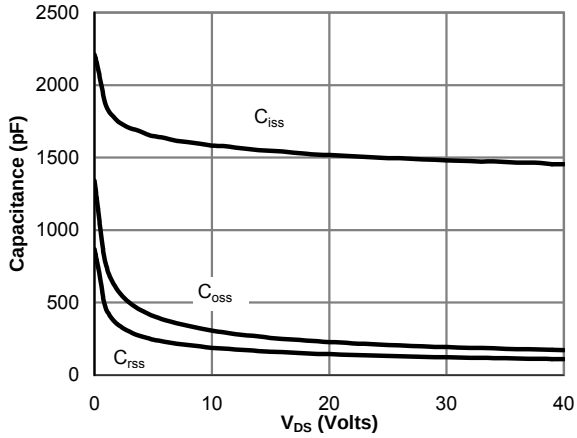



**Figure 8: Capacitance Characteristics**

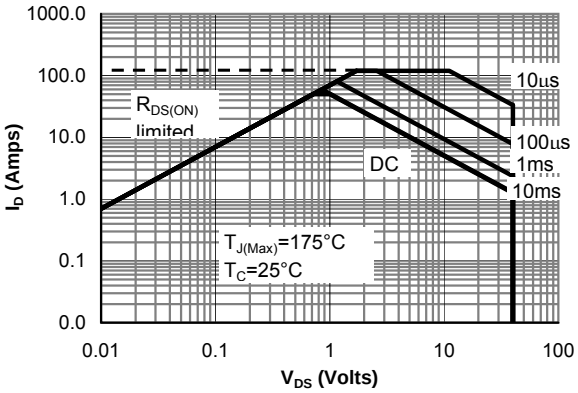



**Figure 9: Maximum Forward Biased Safe Operating Area (Note F)**

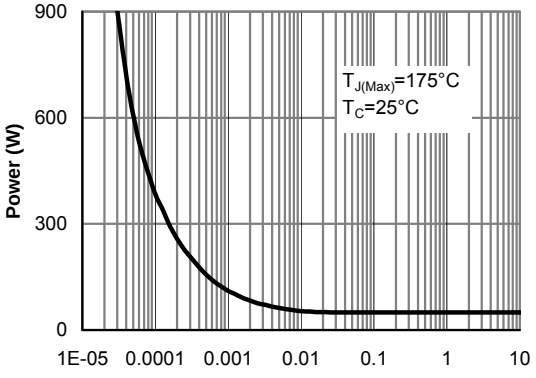



**Figure 10: Single Pulse Power Rating Junction-to-Case (Note F)**

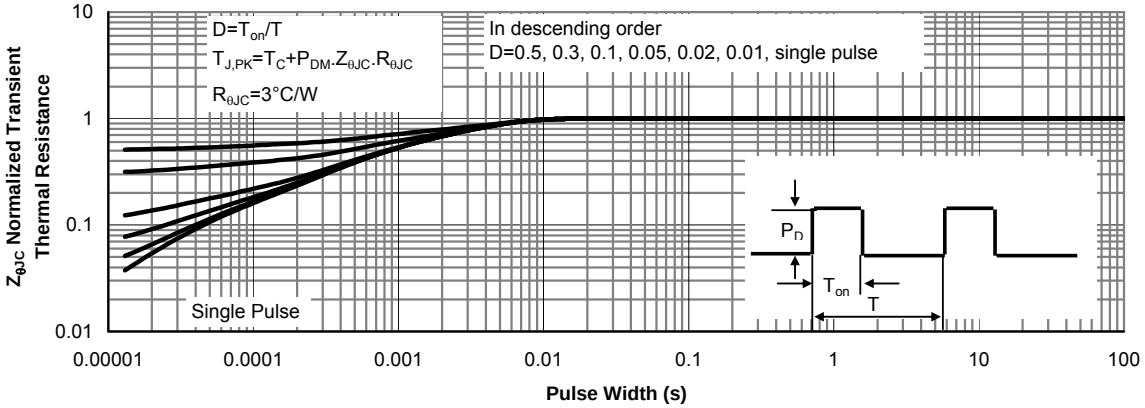



**Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)**

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

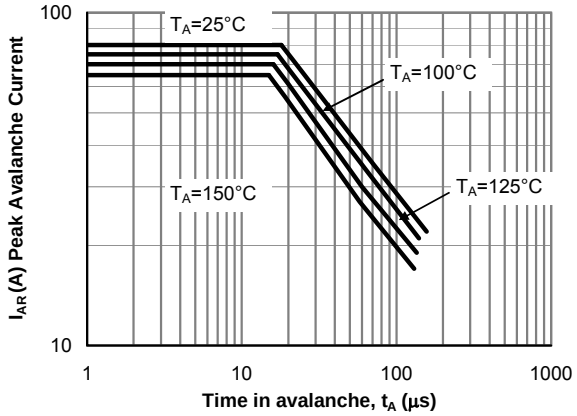



**Figure 12: Single Pulse Avalanche capability (Note C)**

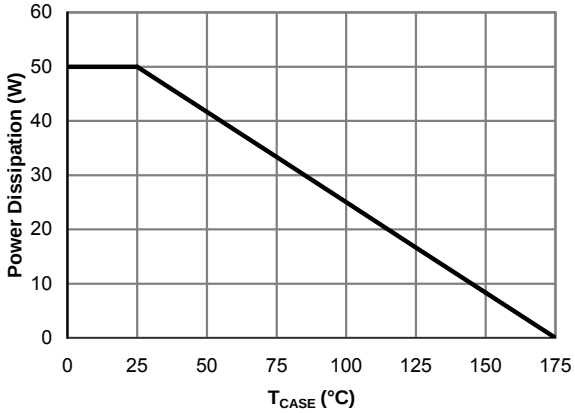



**Figure 13: Power De-rating (Note F)**

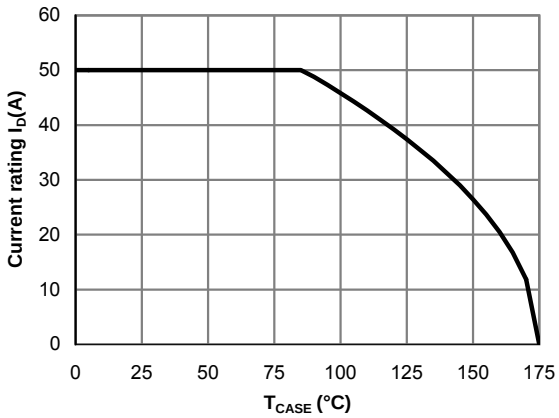



**Figure 14: Current De-rating (Note F)**

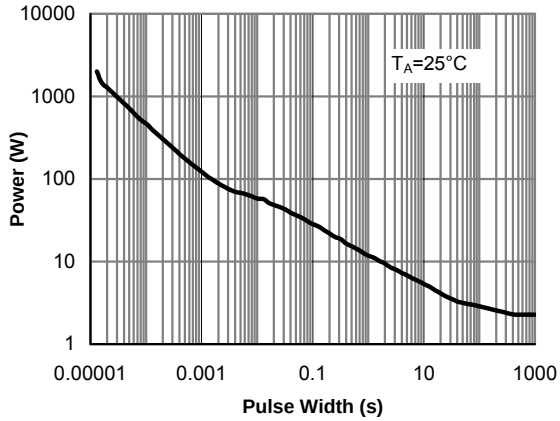



**Figure 15: Single Pulse Power Rating Junction-to-Ambient (Note H)**

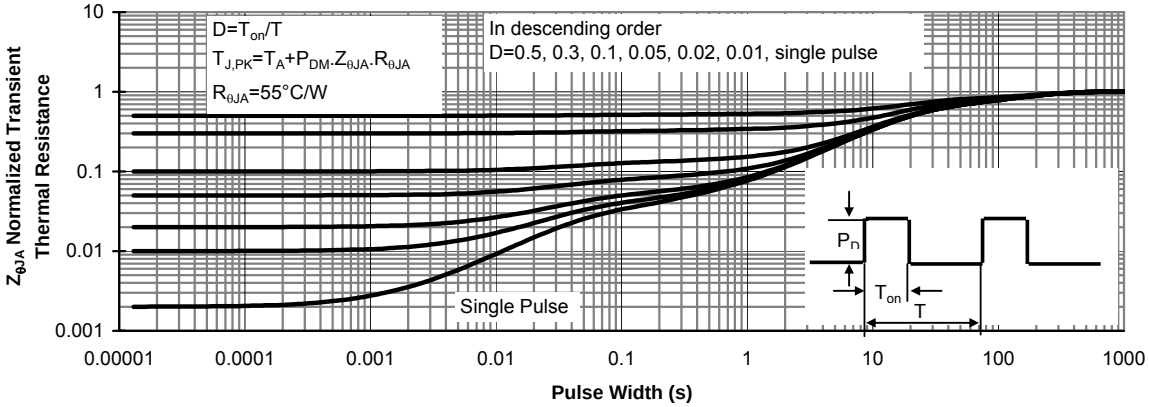
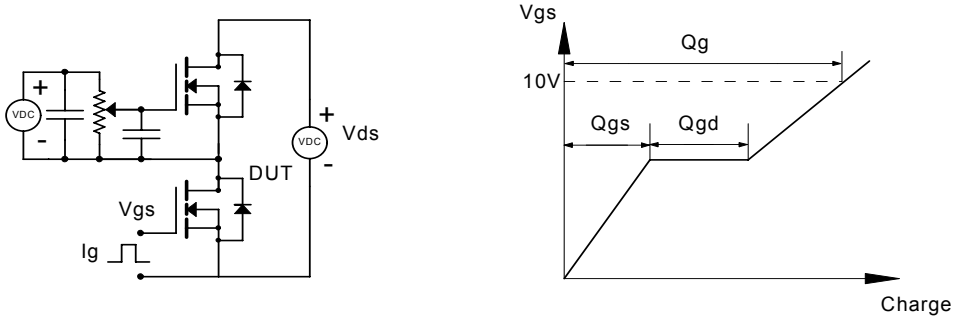
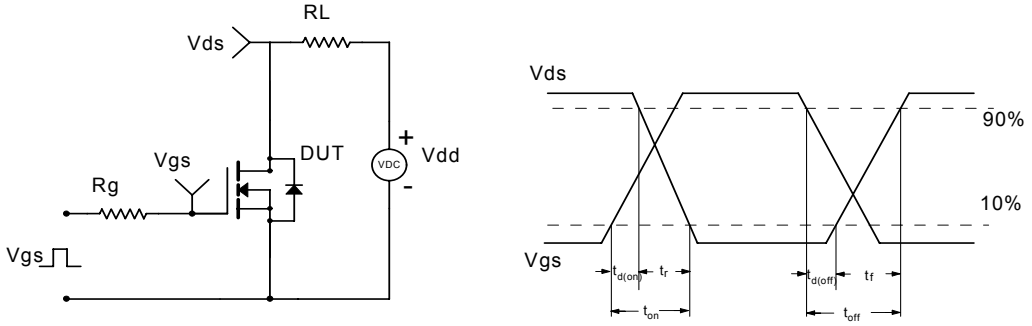



**Figure 16: Normalized Maximum Transient Thermal Impedance (Note H)**

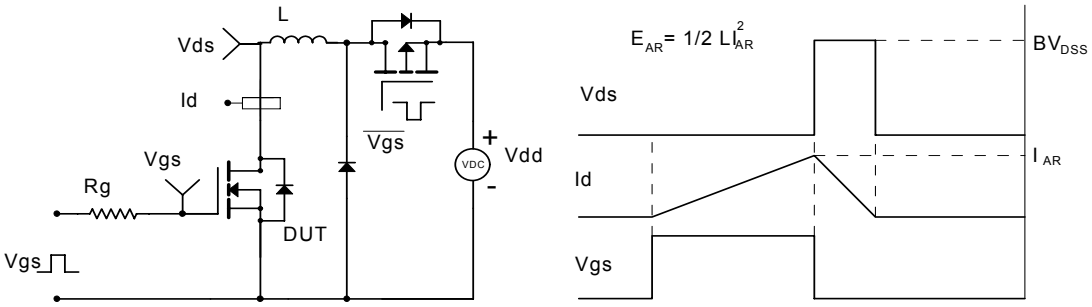
## Gate Charge Test Circuit & Waveform



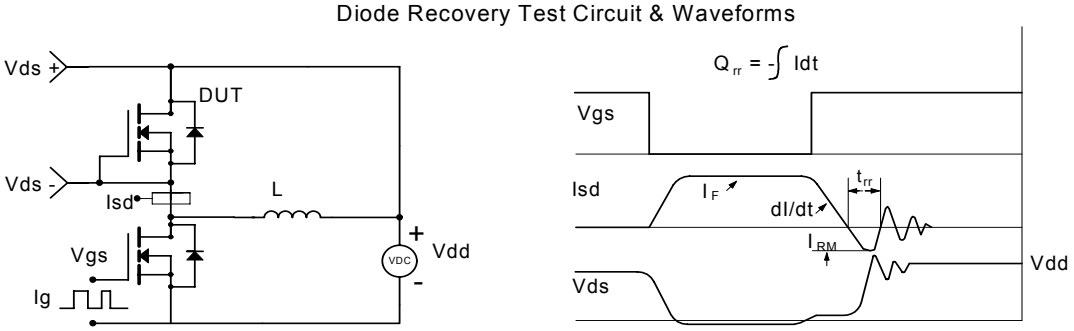

## Resistive Switching Test Circuit & Waveforms




## Unclamped Inductive Switching (UIS) Test Circuit & Waveforms



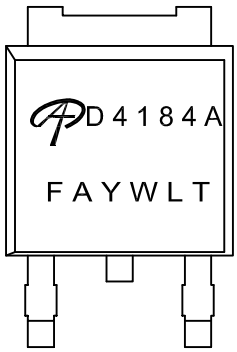

## Diode Recovery Test Circuit & Waveforms



ALPHA & OMEGA SEMICONDUCTOR

| Document No. | PD-01139 |
|---|---|
| Version | A |
| Title | AOD4184A Marking Description |

DPAK (TO-252) PACKAGE MARKING DESCRIPTION




Green product

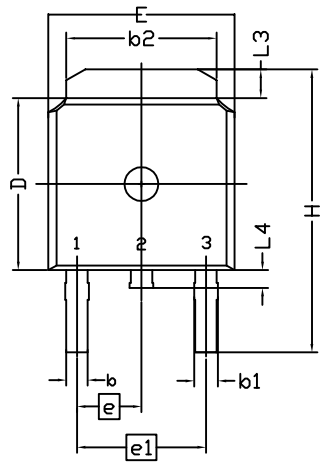
NOTE:
LOGO - AOS Logo
D4184A - Part number code
F - Fab code
A - Assembly location code
Y - Year code
W - Week code
L&T - Assembly lot code

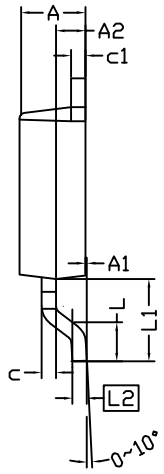
| PART NO. | DESCRIPTION | CODE |
|---|---|---|
| AOD4184A | Green product | D4184A |
| AOD4184AL | Green product | D4184A |

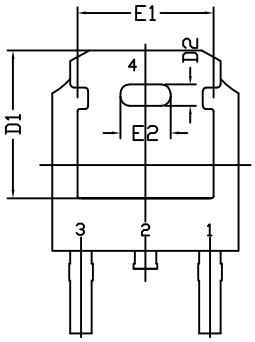
**ALPHA & OMEGA**
*SEMICONDUCTOR, LTD.*

| Document No. | PO−00009 |
|---|---|
| Version | S |

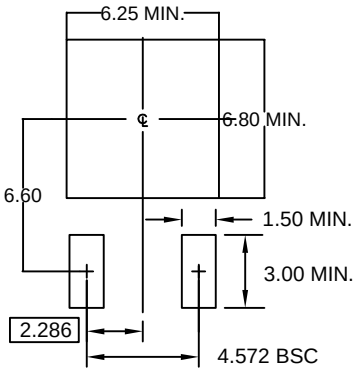
# TO252(DPAK) PACKAGE OUTLINE




RECOMMENDED LAND PATTERN




UNIT: mm

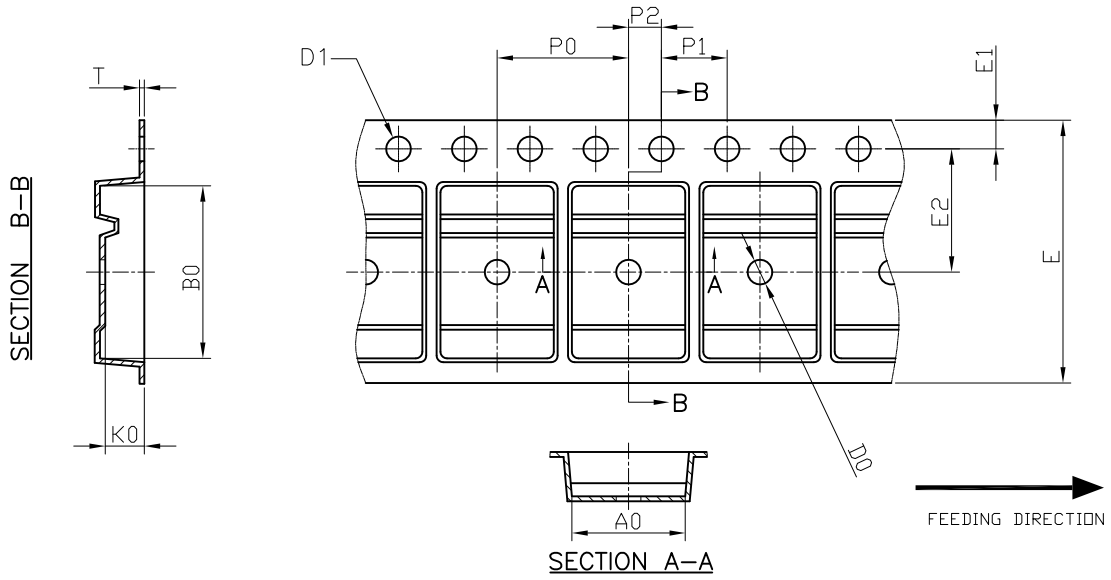
| SYMBOL | DIMENSION IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 2.184 | 2.286 | 2.388 | 0.086 | 0.090 | 0.094 |
| A1 | 0.000 | ----- | 0.127 | 0.000 | ----- | 0.005 |
| A2 | 0.889 | 1.041 | 1.143 | 0.035 | 0.041 | 0.045 |
| b | 0.635 | 0.762 | 0.889 | 0.025 | 0.030 | 0.035 |
| b1 | 0.762 | 0.840 | 1.143 | 0.030 | 0.033 | 0.045 |
| b2 | 4.953 | 5.340 | 5.461 | 0.195 | 0.210 | 0.215 |
| c | 0.450 | 0.508 | 0.610 | 0.018 | 0.020 | 0.024 |
| c1 | 0.450 | 0.508 | 0.610 | 0.018 | 0.020 | 0.024 |
| D | 5.969 | 6.096 | 6.223 | 0.235 | 0.240 | 0.245 |
| D1 | 5.210 | 5.249 | 5.380 | 0.205 | 0.207 | 0.212 |
| D2 | 0.662 | 0.762 | 0.862 | 0.026 | 0.030 | 0.034 |
| E | 6.350 | 6.604 | 6.731 | 0.250 | 0.260 | 0.265 |
| E1 | 4.318 | 4.826 | 4.901 | 0.170 | 0.190 | 0.193 |
| E2 | 1.678 | 1.778 | 1.878 | 0.066 | 0.070 | 0.074 |
| e | 2.286 BSC | | | 0.090 BSC | | |
| e1 | 4.572 BSC | | | 0.180 BSC | | |
| H | 9.398 | 10.033 | 10.414 | 0.370 | 0.395 | 0.410 |
| L | 1.270 | 1.520 | 2.032 | 0.050 | 0.060 | 0.080 |
| L1 | 2.921 REF. | | | 0.115REF. | | |
| L2 | 0.408 | 0.508 | 0.608 | 0.016 | 0.020 | 0.024 |
| L3 | 0.889 | 1.016 | 1.270 | 0.035 | 0.040 | 0.050 |
| L4 | 0.635 | ----- | 1.016 | 0.025 | ----- | 0.040 |

NOTE
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS. MOLD FLASH SHOULD BE LESS THAN 6 MILS.
2. DIMENSION L IS MEASURED IN GAUGE PLANE
3. TOLERANCE 0.10 mm UNLESS OTHERWISE SPECIFIED
4. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
5. REFER TO JEDEC TO-252 (AA)

ALPHA & OMEGA SEMICONDUCTOR

# DPAK Tape and Reel Data

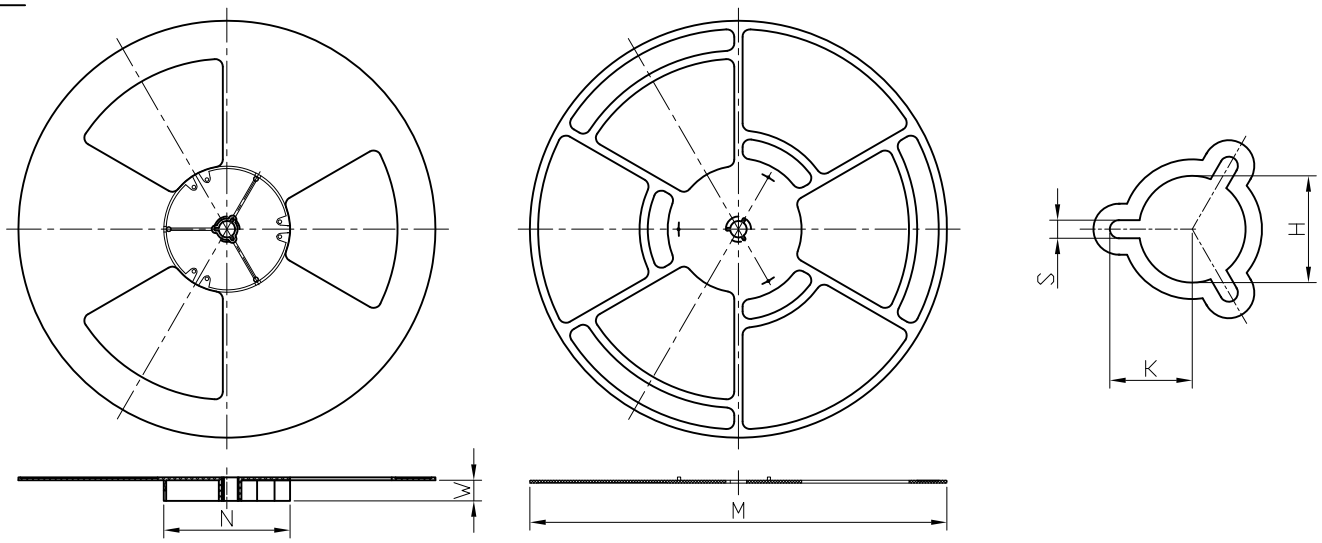
## DPAK Carrier Tape




UNIT: MM

| PACKAGE | A0 | B0 | K0 | D0 | D1 | E | E1 | E2 | P0 | P1 | P2 | T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DPAK (16 mm) | 6.90 ±0.10 | 10.50 ±0.10 | 2.50 ±0.10 | 1.50 +0.1 −0 | 1.50 +0.1 −0 | 16.00 ±0.30 | 1.75 ±0.10 | 7.50 ±0.10 | 8.00 ±0.10 | 4.00 ±0.10 | 2.00 ±0.10 | 0.30 ±0.05 |

## DPAK Reel



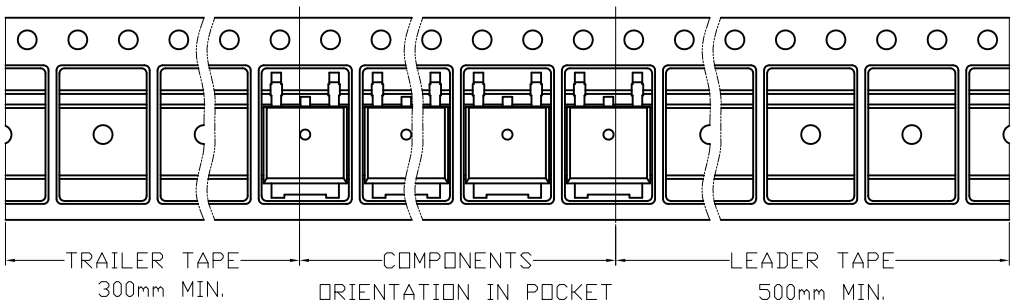

UNIT: MM

| TAPE SIZE | REEL SIZE | M | N | W | H | K | S |
|---|---|---|---|---|---|---|---|
| 16 mm | ø330 | ø330.00 +0.25 −4.00 | ø100.00 ±0.2 | 16.4 +2.0 −0.0 | ø13.00 +0.50 −0.20 | 10.5 ±0.25 | 2.2 ±0.25 |

## DPAK Tape

Leader / Trailer & Orientation

Unit Per Reel: 2500pcs



# AOS Semiconductor
# Product Reliability Report

## AOD4184A, rev B

**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 AOD4184A. 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 AOD4184A 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 AOD4184A combines advanced trench MOSFET technology with a low resistance package to provide extremely low $R_{DS(ON)}$. This device is well suited for high current load applications.

-RoHS Compliant
-Halogen Free

| **Absolute Maximum Ratings $T_A$=25°C unless otherwise noted** | | | | |
|---|---|---|---|---|
| **Parameter** | | **Symbol** | **Maximum** | **Units** |
| Drain-Source Voltage | | $V_{DS}$ | 40 | V |
| Gate-Source Voltage | | $V_{GS}$ | ±20 | V |
| Continuous Drain Current [G] | $T_C$=25°C | $I_D$ | 50 | A |
| | $T_C$=100°C | | 39 | |
| Pulsed Drain Current [C] | | $I_{DM}$ | 120 | |
| Continuous Drain Current | $T_A$=25°C | $I_{DSM}$ | 13 | A |
| | $T_A$=70°C | | 10 | |
| Avalanche Current [C] | | $I_{AS}$, $I_{AR}$ | 35 | A |
| Avalanche energy L=0.1mH [C] | | $E_{AS}$, $E_{AR}$ | 61 | mJ |
| Power Dissipation [B] | $T_C$=25°C | $P_D$ | 50 | W |
| | $T_C$=100°C | | 25 | |
| Power Dissipation [A] | $T_A$=25°C | $P_{DSM}$ | 2.3 | W |
| | $T_A$=70°C | | 1.5 | |
| 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] | t ≤ 10s | $R_{\theta JA}$ | 18 | 22 | °C/W |
| Maximum Junction-to-Ambient [A D] | Steady-State | | 44 | 55 | °C/W |
| Maximum Junction-to-Case | Steady-State | $R_{\theta JC}$ | 2.4 | 3 | °C/W |

ALPHA & OMEGA SEMICONDUCTOR

## II. Die / Package Information:

| | AOD4184A |
|---|---|
| **Process** | Standard sub-micron<br>Low voltage N channel process |
| **Package Type** | 3 leads TO252 |
| **Lead Frame** | Bare Cu |
| **Die Attach** | Soft solder |
| **Bond wire** | G:1.3 mils Au; S: 20mils Al |
| **Mold Material** | Epoxy resin with silica filler |
| **Flammability Rating** | UL-94 V-0 |
| **Backside Metallization** | Ti / Ni / Ag |
| **Moisture Level** | Up to Level 1 * |

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

## III. Result of Reliability Stress for AOD4184A

| Test Item | Test Condition | Time Point | Lot Attribution | Total Sample size | Number of Failures |
|---|---|---|---|---|---|
| **Solder Reflow Precondition** | **168hr 85°c /85%RH +3 cycle reflow@260°c** | **-** | **9 lots** | **1210pcs** | **0** |
| **HTGB** | **Temp = 150°c , Vgs=100% of Vgsmax** | **168hrs<br>500 hrs<br>1000 hrs** | **1 lot<br>(Note A*)** | **77pcs<br>77 pcs / lot** | **0** |
| **HTRB** | **Temp = 150°c , Vds=80% of Vdsmax** | **168hrs<br>500 hrs<br>1000 hrs** | **1 lot<br>(Note A*)** | **77pcs<br>77 pcs / lot** | **0** |
| **HAST** | **130 +/- 2°c , 85%RH, 33.3 psi, Vgs = 80% of Vgs max** | **100 hrs** | **9 lots<br>(Note B**)** | **495pcs<br>55 pcs / lot** | **0** |
| **Pressure Pot** | **121°c , 29.7psi, RH=100%** | **96 hrs** | **5 lots<br>(Note B**)** | **275pcs<br>55 pcs / lot** | **0** |
| **Temperature Cycle** | **-65°c to 150°c , air to air,** | **250 / 500 cycles** | **8 lots<br>(Note B**)** | **440pcs<br>55 pcs / lot** | **0** |

## III. Result of Reliability Stress for AOD4184A

**Continues**

| | | | | | |
|---|---|---|---|---|---|
| **DPA** | **Internal Vision**<br>**Cross-section**<br>**X-ray** | **NA** | **5**<br>**5**<br>**5** | **5**<br>**5**<br>**5** | **0** |
| **CSAM** | | **NA** | **5** | **5** | **0** |
| **Bond Integrity** | **Room Temp**<br>**150°c bake**<br>**150°c bake** | **0hr**<br>**250hr**<br>**500hr** | **40**<br>**40**<br>**40** | **40 wires**<br>**40 wires**<br>**40 wires** | **0** |
| **Solderability** | **245°c** | **5 sec** | **15** | **15 leads** | **0** |
| **Solder dunk** | **260°c** | **10secs**<br>**3 cycles** | **1** | **30 units** | **0** |

**Note A:** The HTGB and HTRB reliability data presents total of available AOD4184A burn-in data up to the published date.
**Note B:** The pressure pot, temperature cycle and HAST reliability data for AOD4184A comes from the AOS generic package qualification data.

## IV. Reliability Evaluation

## FIT rate (per billion): 46
## MTTF = 2478 years

The presentation of FIT rate for the individual product reliability is restricted by the actual burn-in sample size of the selected product (AOD4184A). 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)**]** = $1.83 \times 10^9$ **/ [**2x2x77x500x258**]** = 46
**MTTF =** $10^9$ / FIT = $2.17 \times 10^7$hrs = 2478 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, $8.617164 \times 10^{-5}$eV / K