

## AOD4189

### P-Channel Enhancement Mode Field Effect Transistor

#### General Description

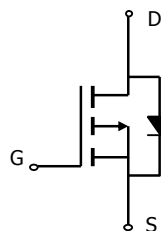
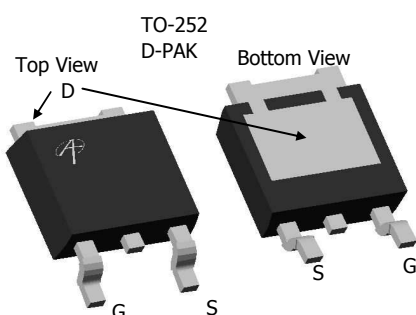
The AOD4189 uses advanced trench technology and design to provide excellent  $R_{DS(ON)}$  with low gate charge. With the excellent thermal resistance of the DPAK package, this device is well suited for high current load applications.

- RoHS Compliant
- Halogen Free\*

#### Features

$V_{DS}$  (V) = -40V  
 $I_D$  = -40A ( $V_{GS}$  = -10V)  
 $R_{DS(ON)} < 22m\Omega$  ( $V_{GS}$  = -10V)  
 $R_{DS(ON)} < 29m\Omega$  ( $V_{GS}$  = -4.5V)

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



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

| Parameter                                                 | Symbol         | Maximum    | Units            |
|-----------------------------------------------------------|----------------|------------|------------------|
| Drain-Source Voltage                                      | $V_{DS}$       | -40        | V                |
| Gate-Source Voltage                                       | $V_{GS}$       | $\pm 20$   | V                |
| Continuous Drain Current <sup>B,H</sup>                   | $I_D$          | -40        | A                |
| $T_C=25^\circ\text{C}$                                    |                | -28        |                  |
| $T_C=100^\circ\text{C}$                                   | $I_{DM}$       | -50        |                  |
| Pulsed Drain Current <sup>C</sup>                         | $I_{AR}$       | -35        |                  |
| Avalanche Current <sup>C</sup>                            | $E_{AR}$       | 61         | mJ               |
| Repetitive avalanche energy $L=0.1\text{mH}$ <sup>C</sup> | $P_D$          | 62.5       | W                |
| Power Dissipation <sup>B</sup>                            |                | 31         |                  |
| $T_C=25^\circ\text{C}$                                    | $P_{DSM}$      | 2.5        |                  |
| $T_C=100^\circ\text{C}$                                   |                | 1.6        |                  |
| Power Dissipation <sup>A</sup>                            | $T_J, T_{STG}$ | -55 to 175 | $^\circ\text{C}$ |

#### Thermal Characteristics

| Parameter                                  | Symbol          | Typ | Max | Units              |
|--------------------------------------------|-----------------|-----|-----|--------------------|
| Maximum Junction-to-Ambient <sup>A,G</sup> | $R_{\theta JA}$ | 15  | 20  | $^\circ\text{C/W}$ |
| $t \leq 10\text{s}$                        |                 | 41  | 50  | $^\circ\text{C/W}$ |
| Maximum Junction-to-Ambient <sup>A,G</sup> | $R_{\theta JC}$ | 2   | 2.4 | $^\circ\text{C/W}$ |
| Steady-State                               |                 |     |     |                    |

**Electrical Characteristics (T<sub>J</sub>=25°C unless otherwise noted)**

| Symbol                      | Parameter                             | Conditions                                                                                  | Min  | Typ      | Max      | Units |
|-----------------------------|---------------------------------------|---------------------------------------------------------------------------------------------|------|----------|----------|-------|
| <b>STATIC PARAMETERS</b>    |                                       |                                                                                             |      |          |          |       |
| BV <sub>DSS</sub>           | Drain-Source Breakdown Voltage        | I <sub>D</sub> =-250μA, V <sub>GS</sub> =0V                                                 | -40  |          |          | V     |
| I <sub>DSS</sub>            | Zero Gate Voltage Drain Current       | V <sub>DS</sub> =-40V, V <sub>GS</sub> =0V<br>T <sub>J</sub> =55°C                          |      |          | -1<br>-5 | μA    |
| I <sub>GSS</sub>            | Gate-Body leakage current             | V <sub>DS</sub> =0V, V <sub>GS</sub> = ±20V                                                 |      |          | ±100     | nA    |
| V <sub>GS(th)</sub>         | Gate Threshold Voltage                | V <sub>DS</sub> =V <sub>GS</sub> I <sub>D</sub> =-250μA                                     | -1.7 | -1.9     | -3       | V     |
| I <sub>D(ON)</sub>          | On state drain current                | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-5V                                                 | -50  |          |          | A     |
| R <sub>DS(ON)</sub>         | Static Drain-Source On-Resistance     | V <sub>GS</sub> =-10V, I <sub>D</sub> =-12A<br>T <sub>J</sub> =125°C                        |      | 18<br>27 | 22<br>33 | mΩ    |
|                             |                                       | V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-8A                                                 |      | 23       | 29       |       |
| g <sub>FS</sub>             | Forward Transconductance              | V <sub>DS</sub> =-5V, I <sub>D</sub> =-12A                                                  |      | 35       |          | S     |
| V <sub>SD</sub>             | Diode Forward Voltage                 | I <sub>S</sub> =-1A, V <sub>GS</sub> =0V                                                    |      | -0.74    | -1       | V     |
| I <sub>S</sub>              | Maximum Body-Diode Continuous Current |                                                                                             |      |          | -20      | A     |
| <b>DYNAMIC PARAMETERS</b>   |                                       |                                                                                             |      |          |          |       |
| C <sub>iss</sub>            | Input Capacitance                     | V <sub>GS</sub> =0V, V <sub>DS</sub> =-20V, f=1MHz                                          |      | 1870     |          | pF    |
| C <sub>oss</sub>            | Output Capacitance                    |                                                                                             |      | 185      |          | pF    |
| C <sub>rss</sub>            | Reverse Transfer Capacitance          |                                                                                             |      | 155      |          | pF    |
| R <sub>g</sub>              | Gate resistance                       | V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, f=1MHz                                            | 2.5  | 4.5      | 6.5      | Ω     |
| <b>SWITCHING PARAMETERS</b> |                                       |                                                                                             |      |          |          |       |
| Q <sub>g</sub> (-10V)       | Total Gate Charge                     | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-20V,<br>I <sub>D</sub> =-12A                       |      | 31.4     | 41       | nC    |
| Q <sub>g</sub> (-4.5V)      | Total Gate Charge                     |                                                                                             |      | 7.9      | 10       |       |
| Q <sub>gs</sub>             | Gate Source Charge                    |                                                                                             |      | 7.6      |          | nC    |
| Q <sub>gd</sub>             | Gate Drain Charge                     |                                                                                             |      | 6.2      |          | nC    |
| t <sub>D(on)</sub>          | Turn-On DelayTime                     | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-20V, R <sub>L</sub> =1.6Ω,<br>R <sub>GEN</sub> =3Ω |      | 10       |          | ns    |
| t <sub>r</sub>              | Turn-On Rise Time                     |                                                                                             |      | 18       |          | ns    |
| t <sub>D(off)</sub>         | Turn-Off DelayTime                    |                                                                                             |      | 38       |          | ns    |
| t <sub>f</sub>              | Turn-Off Fall Time                    |                                                                                             |      | 24       |          | ns    |
| t <sub>rr</sub>             | Body Diode Reverse Recovery Time      | I <sub>F</sub> =-12A, dI/dt=100A/μs                                                         |      | 32       | 42       | ns    |
| Q <sub>rr</sub>             | Body Diode Reverse Recovery Charge    | I <sub>F</sub> =-12A, dI/dt=100A/μs                                                         |      | 30       |          | nC    |

A: The value of R<sub>θJA</sub> is measured with the device in a still air environment with T<sub>A</sub>=25°C. The power dissipation P<sub>DSM</sub> and current rating I<sub>DSM</sub> are based on T<sub>J(MAX)</sub>=150°C, using steady state junction-to-ambient thermal resistance.

B: The power dissipation P<sub>D</sub> is based on T<sub>J(MAX)</sub>=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<sub>J(MAX)</sub>=175°C.

D: The R<sub>θJA</sub> is the sum of the thermal impedance from junction to case R<sub>θJC</sub> and case to ambient.

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

F: These curves are based on the junction-to-case thermal impedance which is measured with the device mounted to a large heatsink, assuming a maximum junction temperature of T<sub>J(MAX)</sub>=175°C. The SOA curve provides a single pulse rating.

G: 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<sub>A</sub>=25°C.

H: The maximum current rating is limited by bond-wires.

\*This device is guaranteed green after data code 8X11 (Sep 1<sup>ST</sup> 2008).

Rev1: Oct 2008

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## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

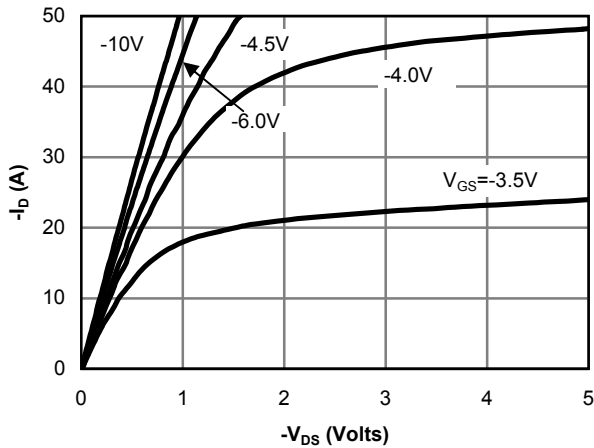


Figure 1: On-Region Characteristics

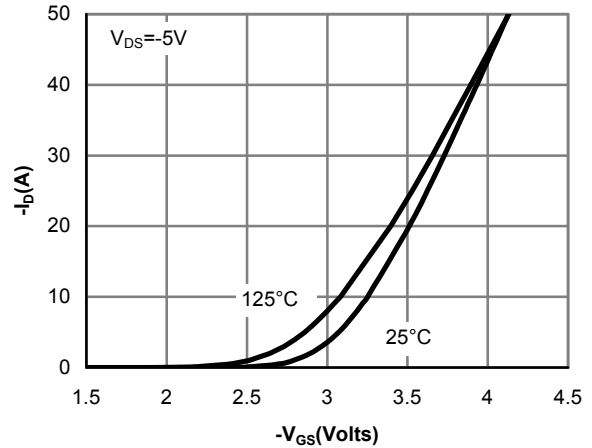


Figure 2: Transfer Characteristics

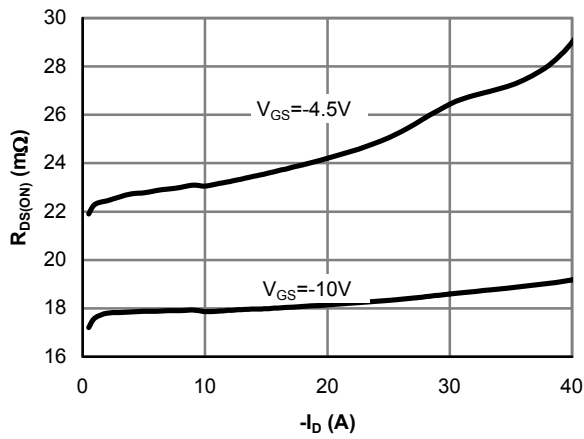


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

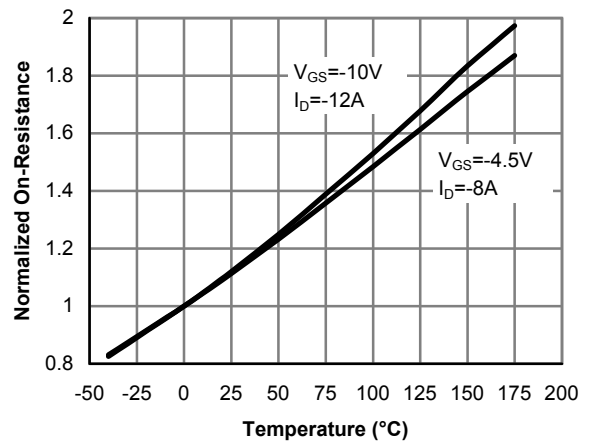


Figure 4: On-Resistance vs. Junction Temperature

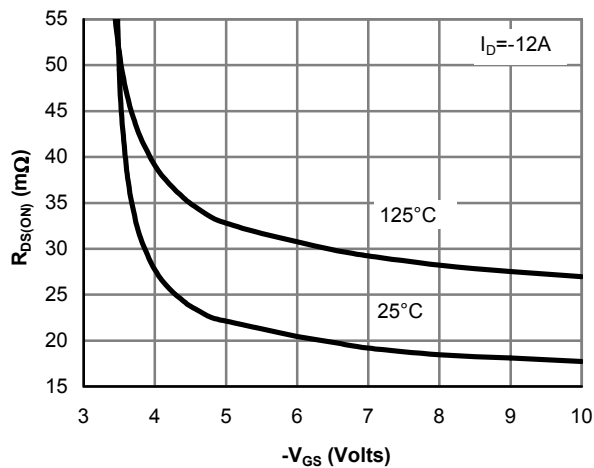


Figure 5: On-Resistance vs. Gate-Source Voltage

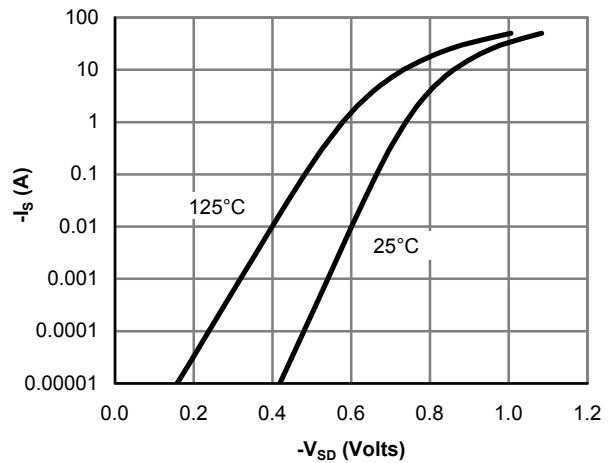


Figure 6: Body-Diode Characteristics

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

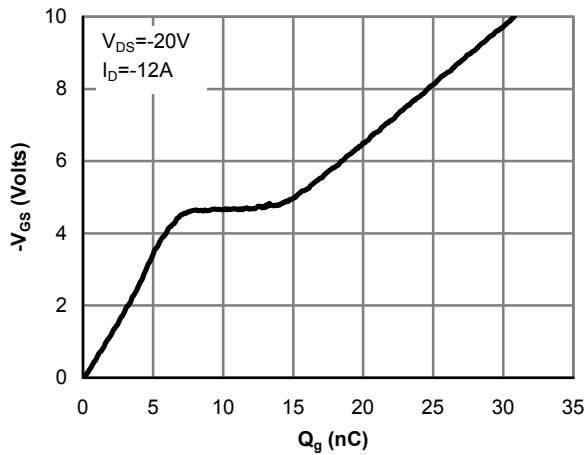


Figure 7: Gate-Charge Characteristics

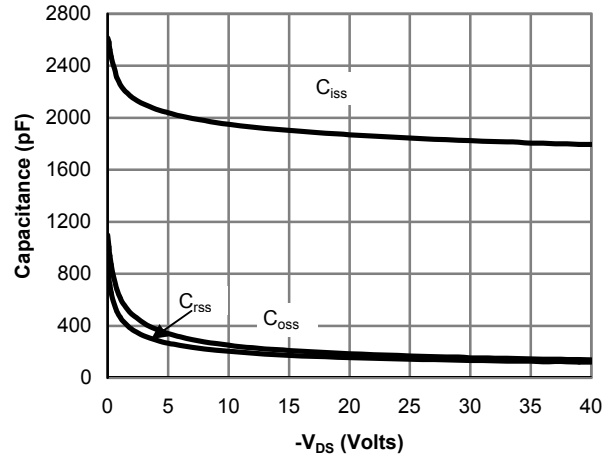


Figure 8: Capacitance Characteristics

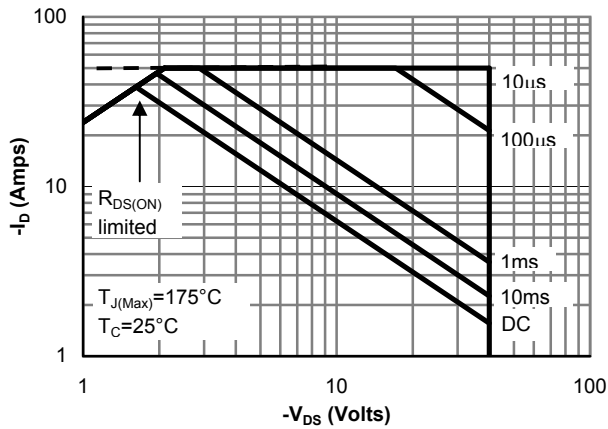


Figure 9: Maximum Forward Biased Safe Operating Area (Note F)

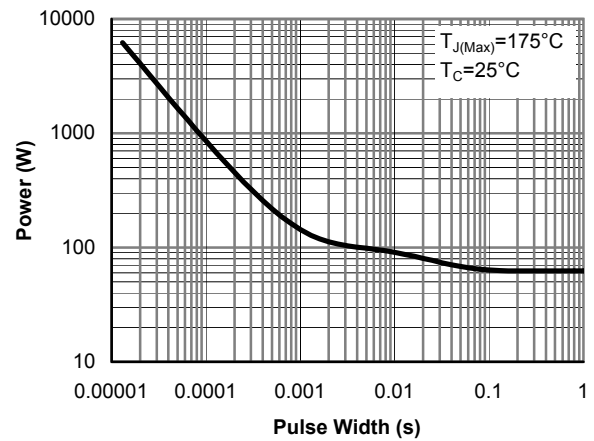


Figure 10: Single Pulse Power Rating Junction-to-Case (Note F)

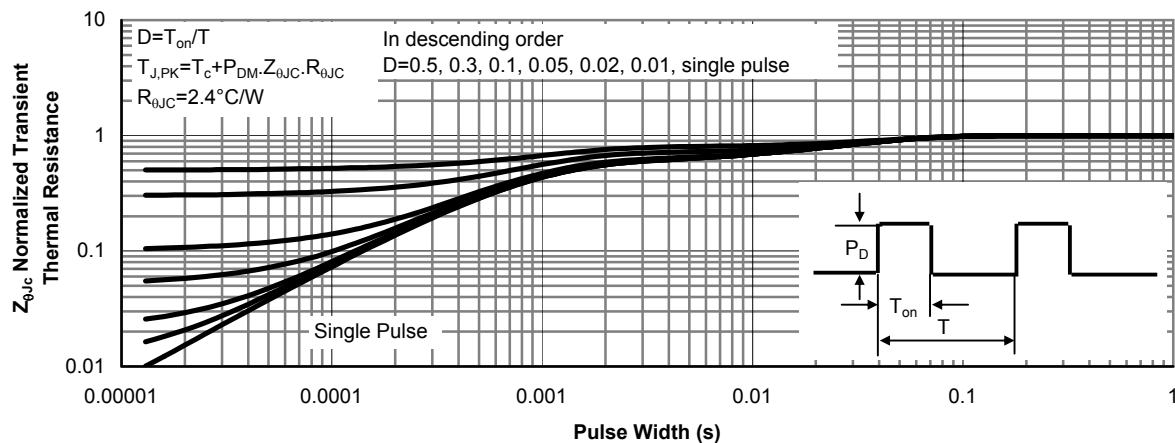


Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

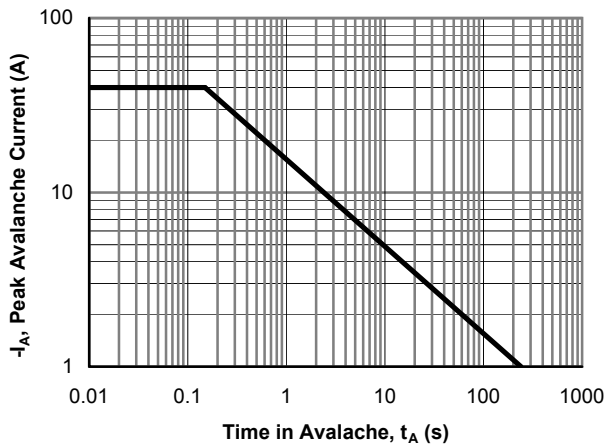


Figure 12: Single Pulse Avalanche Capability

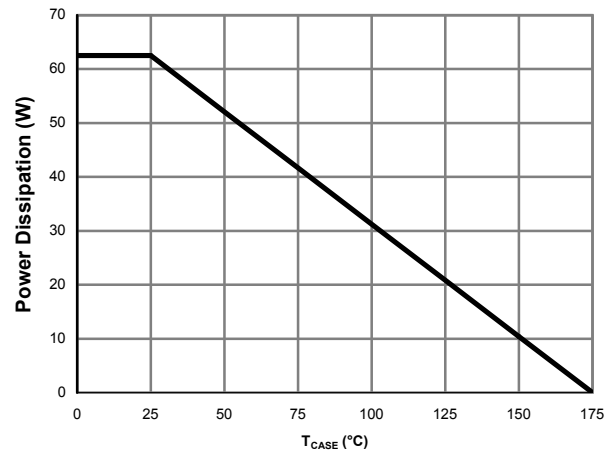


Figure 13: Power De-rating (Note B)

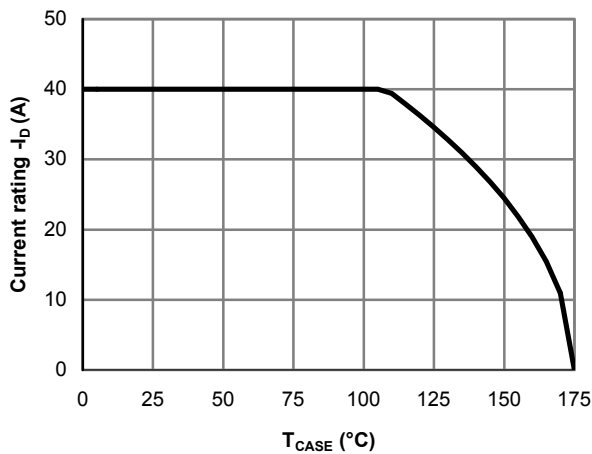


Figure 14: Current De-rating (Note B)

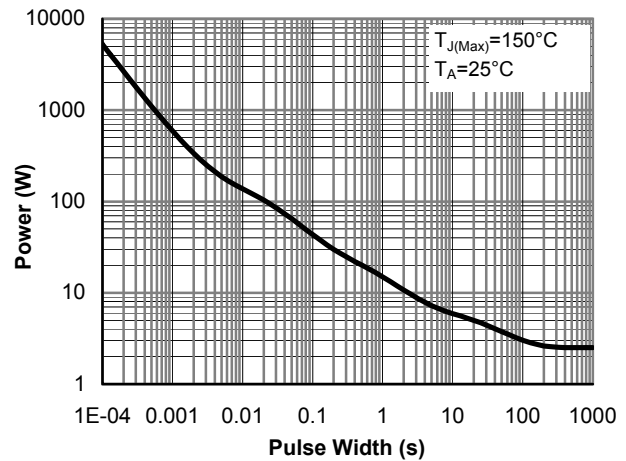


Figure 15: Single Pulse Power Rating Junction-to-Ambient (Note G)

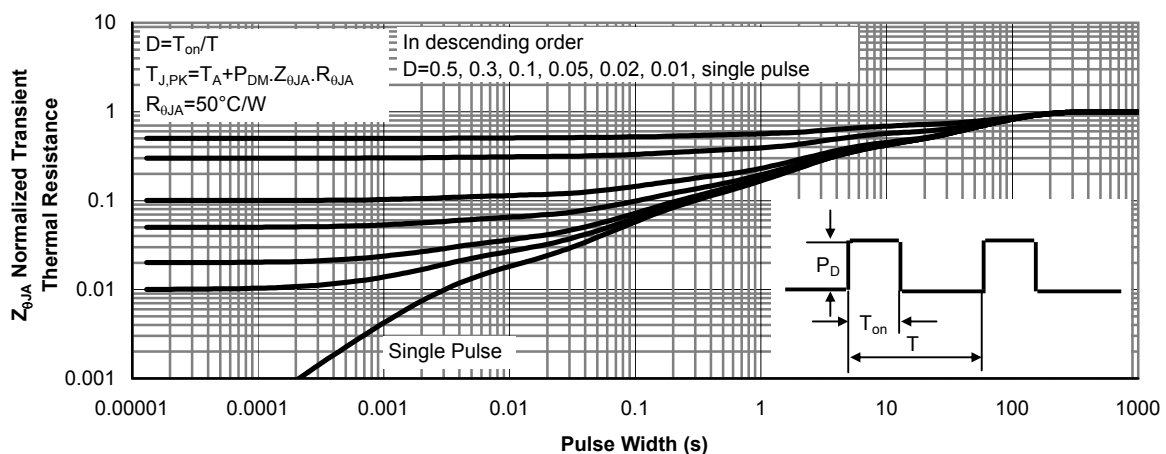
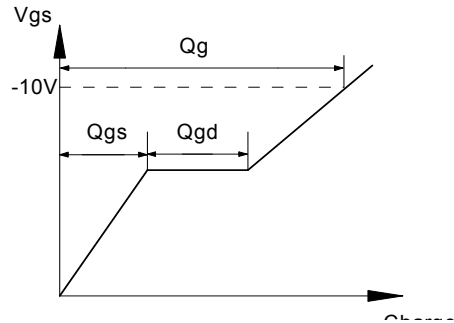
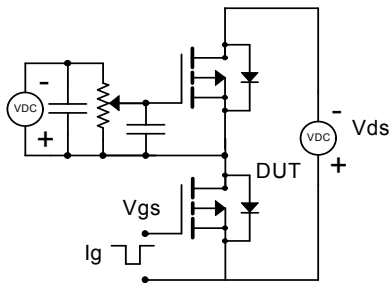
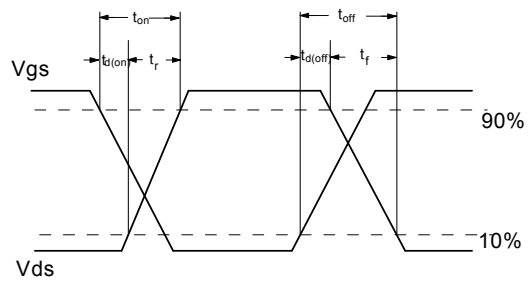
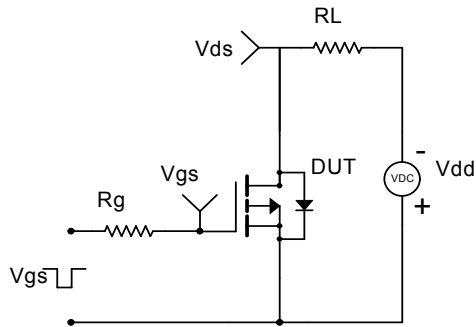


Figure 16: Normalized Maximum Transient Thermal Impedance (Note G)

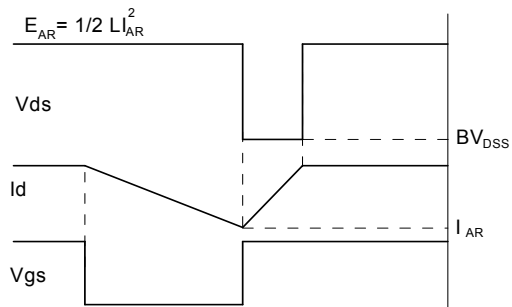
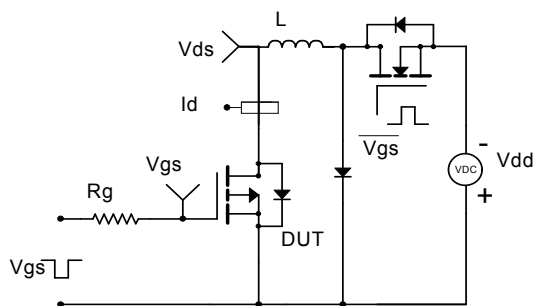
### Gate Charge Test Circuit & Waveform



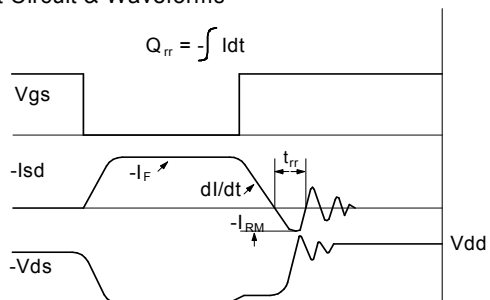
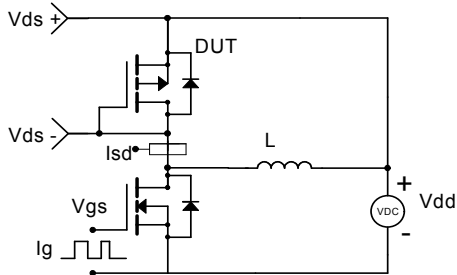
### Resistive Switching Test Circuit & Waveforms



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



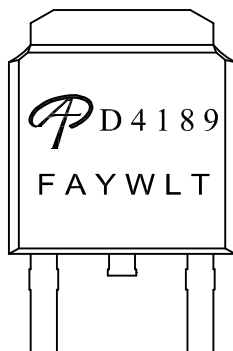
### Diode Recovery Test Circuit & Waveforms





|              |                             |
|--------------|-----------------------------|
| Document No. | PD-00622                    |
| Version      | C                           |
| Title        | AOD4189 Marking Description |

## DPAK PACKAGE MARKING DESCRIPTION



Green product

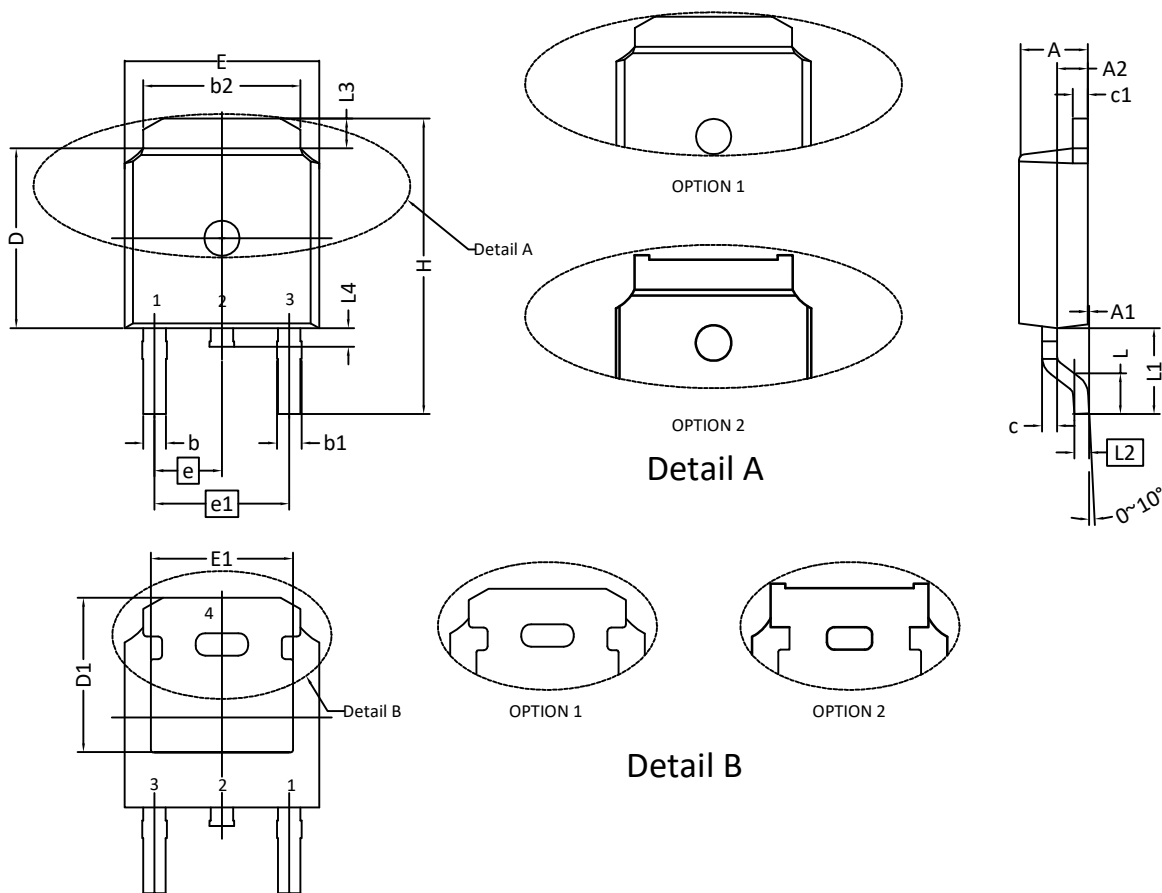
**NOTE:**

LOGO - AOS Logo  
D4189 - Part number code  
F - Fab code  
A - Assembly location code  
Y - Year code  
W - Week code  
L&T - Assembly lot code

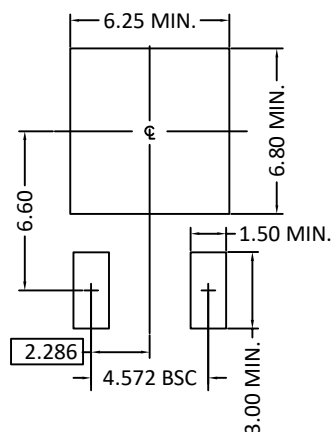
| PART NO. | DESCRIPTION   | CODE  |
|----------|---------------|-------|
| AOD4189  | Green product | D4189 |
| AOD4189L | Green product | D4189 |



## TO252 PACKAGE OUTLINE



### RECOMMENDED LAND PATTERN



UNIT: mm

| SYMBOLS | DIMENSION IN MM |        |        | DIMENSION IN INCHES |       |       |
|---------|-----------------|--------|--------|---------------------|-------|-------|
|         | MIN             | NOM    | MAX    | MIN                 | NOM   | MAX   |
| A       | 2.184           | 2.286  | 2.400  | 0.086               | 0.090 | 0.094 |
| A1      | 0.000           | ---    | 0.200  | 0.000               | ---   | 0.008 |
| A2      | 0.889           | 1.041  | 1.170  | 0.035               | 0.041 | 0.046 |
| b       | 0.635           | 0.762  | 0.889  | 0.025               | 0.030 | 0.035 |
| b1      | 0.680           | 0.840  | 1.143  | 0.027               | 0.033 | 0.045 |
| b2      | 4.953           | 5.340  | 5.500  | 0.195               | 0.210 | 0.217 |
| c       | 0.450           | 0.508  | 0.610  | 0.018               | 0.020 | 0.024 |
| c1      | 0.450           | 0.508  | 0.630  | 0.018               | 0.020 | 0.025 |
| D       | 5.969           | 6.096  | 6.223  | 0.235               | 0.240 | 0.245 |
| D1      | 5.210           | 5.249  | 5.480  | 0.205               | 0.207 | 0.216 |
| E       | 6.350           | 6.604  | 6.800  | 0.250               | 0.260 | 0.268 |
| E1      | 4.318           | 4.826  | 5.230  | 0.170               | 0.190 | 0.206 |
| e       | 2.286 BSC       |        |        | 0.090 BSC           |       |       |
| e1      | 4.572 BSC       |        |        | 0.180 BSC           |       |       |
| H       | 9.398           | 10.033 | 10.500 | 0.370               | 0.395 | 0.413 |
| L       | 1.270           | 1.520  | 2.032  | 0.050               | 0.060 | 0.080 |
| L1      | 2.921 REF.      |        |        | 0.115 REF.          |       |       |
| 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      | 0.600           | ---    | 1.016  | 0.024               | ---   | 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

# ***AOS Semiconductor Product Reliability Report***

**AOD4189**, rev D

**Plastic Encapsulated Device**

**ALPHA & OMEGA Semiconductor, Inc**

**[www.aosmd.com](http://www.aosmd.com)**

Jun, 2018

This AOS product reliability report summarizes the qualification result for AOD4189. 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 AOD4189 passes AOS quality and reliability requirements. The released product will be categorized by the process family and be routine monitored for continuously improving the product quality.

## I. Reliability Stress Test Summary and Results

| Test Item                | Test Condition                                          | Time Point                | Total Sample Size | Number of Failures | Reference Standard         |
|--------------------------|---------------------------------------------------------|---------------------------|-------------------|--------------------|----------------------------|
| HTGB                     | Temp = 150°C ,<br>Vgs=100% of Vgsmax                    | 168 / 500 /<br>1000 hours | 924 pcs           | 0                  | JESD22-A108                |
| HTRB                     | Temp = 150°C ,<br>Vds=80% of Vdsmax                     | 168 / 500 /<br>1000 hours | 924 pcs           | 0                  | JESD22-A108                |
| Precondition<br>(Note A) | 168hr 85°C / 85%RH +<br>3 cycle reflow@260°C<br>(MSL 1) | -                         | 4620 pcs          | 0                  | JESD22-A113                |
| HAST                     | 130°C , 85%RH,<br>33.3 psia,<br>Vds = 80% of Vdsmax     | 96 hours                  | 693 pcs           | 0                  | JESD22-A110                |
| H3TRB                    | 85°C , 85%RH,<br>Vds = 80% of Vdsmax                    | 1000 hours                | 693 pcs           | 0                  | JESD22-A101                |
| Autoclave                | 121°C , 29.7psia,<br>RH=100%                            | 96 hours                  | 924 pcs           | 0                  | JESD22-A102                |
| Temperature<br>Cycle     | -65°C to 150°C ,<br>air to air,                         | 1000cycles                | 924 pcs           | 0                  | JESD22-A104                |
| HTSL                     | Temp = 150°C                                            | 1000 hours                | 693 pcs           | 0                  | JESD22-A103                |
| IOL                      | Δ Tj = 100°C                                            | 15000 cycles              | 693 pcs           | 0                  | MIL-STD-750<br>Method 1037 |

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

Note A: MSL (Moisture Sensitivity Level) 1 based on J-STD-020

## II. Reliability Evaluation

**FIT rate (per billion): 1.91**

**MTTF = 59839 years**

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

**Failure Rate** =  $\text{Chi}^2 \times 10^9 / [2 (N) (H) (Af)] = 1.91$

**MTTF** =  $10^9 / \text{FIT} = 59839$  years

**Chi<sup>2</sup>** = Chi Squared Distribution, determined by the number of failures and confidence interval

**N** = Total Number of units from burn-in tests

**H** = Duration of burn-in testing

**Af** = Acceleration Factor from Test to Use Conditions (Ea = 0.7eV and Tuse = 55°C)

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

**Acceleration Factor ratio list:**

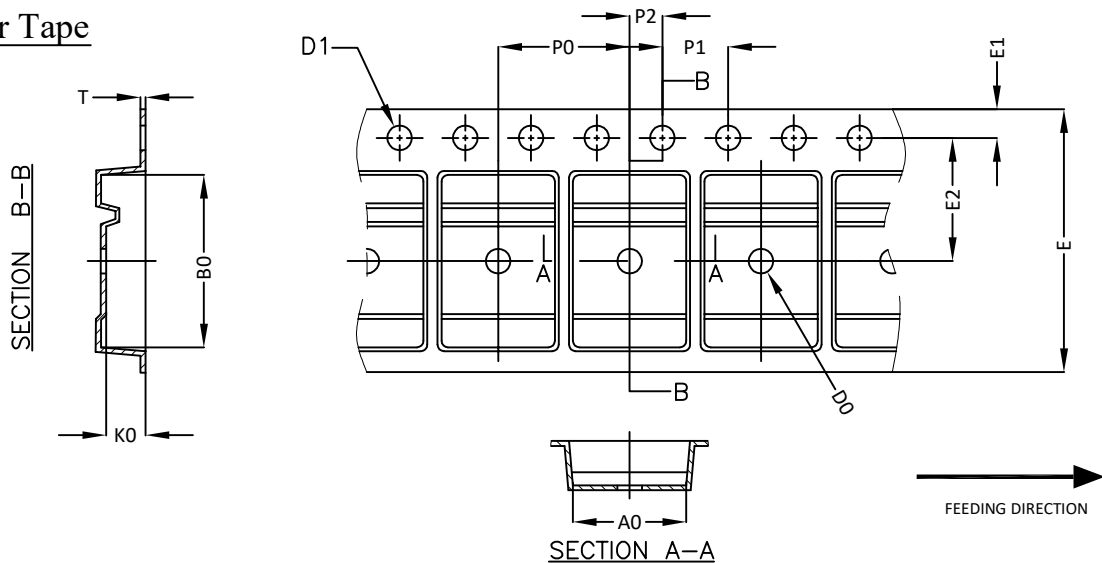
|           | 55 deg C   | 70 deg C  | 85 deg C  | 100 deg C | 115 deg C   | 130 deg C   | 150 deg C |
|-----------|------------|-----------|-----------|-----------|-------------|-------------|-----------|
| <b>Af</b> | <b>259</b> | <b>87</b> | <b>32</b> | <b>13</b> | <b>5.64</b> | <b>2.59</b> | <b>1</b>  |

**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,  $8.617164 \times 10^{-5} \text{ eV} / \text{K}$

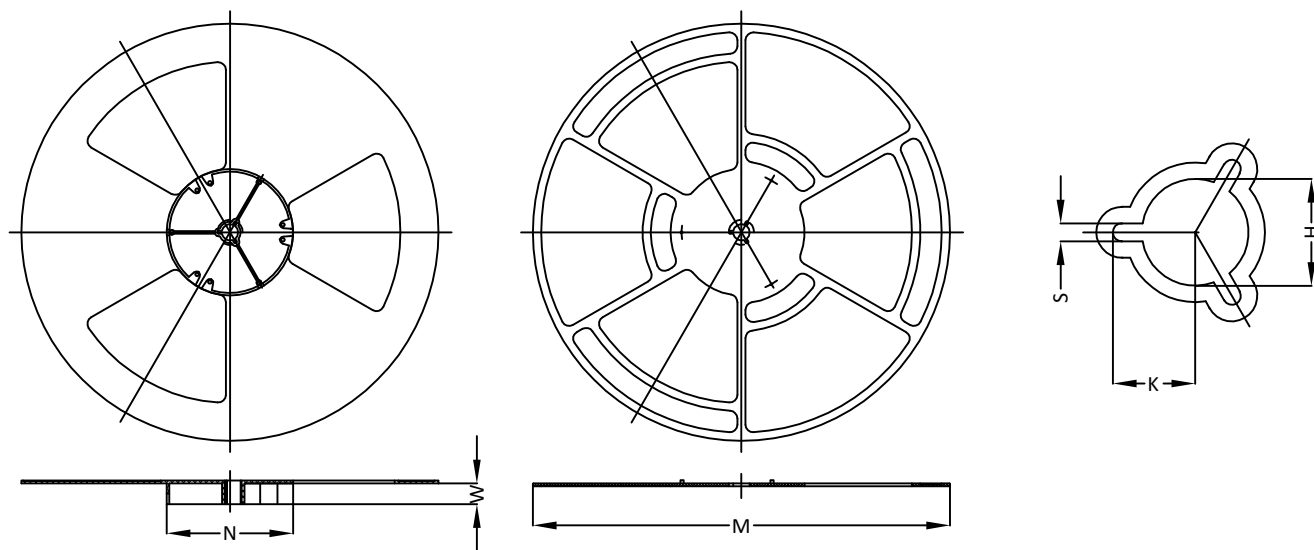
## TO252(DPAK) Carrier Tape



UNIT: MM

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

## TO252(DPAK) Reel



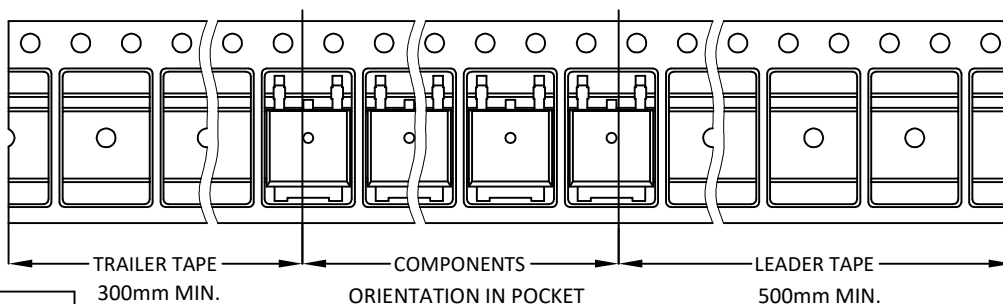
UNIT: MM

| TAPE SIZE | REEL SIZE | M                         | N               | W                    | H                        | K             | S            |
|-----------|-----------|---------------------------|-----------------|----------------------|--------------------------|---------------|--------------|
| 16 mm     | Ø330      | Ø330.00<br>+0.25<br>-4.00 | Ø100.00<br>±0.2 | 16.4<br>+2.0<br>-0.0 | Ø13.00<br>+0.50<br>-0.20 | 10.5<br>±0.25 | 2.2<br>±0.25 |

## TO252(DPAK) Tape

Leader / Trailer  
& Orientation

Unit Per Reel:  
2500pcs



All Dimensions Comply with EAI-481