



### General Description

- Trench Power AlphaMOS-II technology
- Low  $R_{DS(ON)}$
- Low  $C_{iss}$  and  $C_{rss}$
- High Current Capability
- RoHS and Halogen Free Compliant

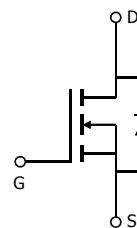
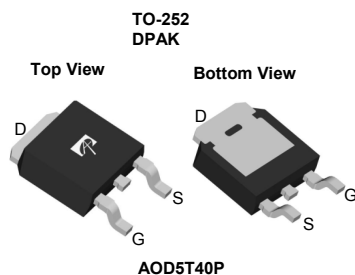
### Applications

- General Lighting for LED and CCFL
- AC/DC Power supplies for Industrial, Consumer, and Telecom

### Product Summary

|                      |                 |
|----------------------|-----------------|
| $V_{DS} @ T_{j,max}$ | 500V            |
| $I_{DM}$             | 15A             |
| $R_{DS(ON),max}$     | < 1.45 $\Omega$ |
| $Q_{g,typ}$          | 5nC             |
| $E_{oss} @ 320V$     | 0.9 $\mu$ J     |

100% UIS Tested  
100%  $R_g$  Tested



| Orderable Part Number | Package Type | Form        | Minimum Order Quantity |
|-----------------------|--------------|-------------|------------------------|
| AOD5T40P              | TO-252       | Tape & Reel | 2500                   |

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

| Parameter                                                                    | Symbol         | Maximum    | Units               |
|------------------------------------------------------------------------------|----------------|------------|---------------------|
| Drain-Source Voltage                                                         | $V_{DS}$       | 400        | V                   |
| Gate-Source Voltage                                                          | $V_{GS}$       | $\pm 30$   | V                   |
| Continuous Drain Current                                                     | $I_D$          | 3.9        | A                   |
|                                                                              |                | 2.5        |                     |
| Pulsed Drain Current <sup>C</sup>                                            | $I_{DM}$       | 15         |                     |
| Avalanche Current <sup>C</sup> $L=1\text{mH}$                                | $I_{AR}$       | 5          | A                   |
| Repetitive avalanche energy <sup>C</sup>                                     | $E_{AR}$       | 13         | mJ                  |
| Single pulsed avalanche energy <sup>H</sup>                                  | $E_{AS}$       | 108        | mJ                  |
| MOSFET dv/dt ruggedness                                                      | dv/dt          | 50         | V/ns                |
| Peak diode recovery dv/dt                                                    |                | 5          |                     |
| Power Dissipation <sup>B</sup>                                               | $P_D$          | 52         | W                   |
|                                                                              |                | 0.4        | W/ $^\circ\text{C}$ |
| Junction and Storage Temperature Range                                       | $T_J, T_{STG}$ | -55 to 150 | $^\circ\text{C}$    |
| Maximum lead temperature for soldering purpose, 1/8" from case for 5 seconds | $T_L$          | 300        | $^\circ\text{C}$    |

### Thermal Characteristics

| Parameter                                  | Symbol          | Typical | Maximum | Units              |
|--------------------------------------------|-----------------|---------|---------|--------------------|
| Maximum Junction-to-Ambient <sup>A,D</sup> | $R_{\theta JA}$ | 45      | 55      | $^\circ\text{C/W}$ |
| Maximum Case-to-sink <sup>A</sup>          | $R_{\theta CS}$ | -       | 0.5     | $^\circ\text{C/W}$ |
| Maximum Junction-to-Case <sup>D,F</sup>    | $R_{\theta JC}$ | 2       | 2.4     | $^\circ\text{C/W}$ |

**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, T <sub>J</sub> =25°C                       | 400 |      |      | V     |
|                                    |                                                           | I <sub>D</sub> =250μA, V <sub>GS</sub> =0V, T <sub>J</sub> =150°C                      |     | 500  |      |       |
| BV <sub>DSS</sub> /ΔT <sub>J</sub> | Breakdown Voltage Temperature Coefficient                 | I <sub>D</sub> =250μA, V <sub>GS</sub> =0V                                             |     | 0.39 |      | V/°C  |
| I <sub>DSS</sub>                   | Zero Gate Voltage Drain Current                           | V <sub>DS</sub> =400V, V <sub>GS</sub> =0V                                             |     |      | 1    | μA    |
|                                    |                                                           | V <sub>DS</sub> =320V, T <sub>J</sub> =125°C                                           |     |      | 10   |       |
| I <sub>GSS</sub>                   | Gate-Body leakage current                                 | V <sub>DS</sub> =0V, V <sub>GS</sub> =±30V                                             |     |      | ±100 | nA    |
| V <sub>GS(th)</sub>                | Gate Threshold Voltage                                    | V <sub>DS</sub> =5V, I <sub>D</sub> =250μA                                             | 3   | 4.2  | 5    | V     |
| R <sub>DS(on)</sub>                | Static Drain-Source On-Resistance                         | V <sub>GS</sub> =10V, I <sub>D</sub> =1A                                               |     | 1.2  | 1.45 | Ω     |
| g <sub>FS</sub>                    | Forward Transconductance                                  | V <sub>DS</sub> =40V, I <sub>D</sub> =1A                                               |     | 1.9  |      | S     |
| V <sub>SD</sub>                    | Diode Forward Voltage                                     | I <sub>S</sub> =1A, V <sub>GS</sub> =0V                                                |     | 0.8  | 1    | V     |
| I <sub>S</sub>                     | Maximum Body-Diode Continuous Current                     |                                                                                        |     |      | 3.9  | A     |
| I <sub>SM</sub>                    | Maximum Body-Diode Pulsed Current <sup>C</sup>            |                                                                                        |     |      | 15   | A     |
| <b>DYNAMIC PARAMETERS</b>          |                                                           |                                                                                        |     |      |      |       |
| C <sub>iss</sub>                   | Input Capacitance                                         | V <sub>GS</sub> =0V, V <sub>DS</sub> =100V, f=1MHz                                     |     | 273  |      | pF    |
| C <sub>oss</sub>                   | Output Capacitance                                        |                                                                                        |     | 16   |      | pF    |
| C <sub>o(er)</sub>                 | Effective output capacitance, energy related <sup>I</sup> | V <sub>GS</sub> =0V, V <sub>DS</sub> =0 to 320V, f=1MHz                                |     | 18   |      | pF    |
| C <sub>o(tr)</sub>                 | Effective output capacitance, time related <sup>J</sup>   |                                                                                        |     | 30   |      | pF    |
| C <sub>rss</sub>                   | Reverse Transfer Capacitance                              | V <sub>GS</sub> =0V, V <sub>DS</sub> =100V, f=1MHz                                     |     | 1.5  |      | pF    |
| R <sub>g</sub>                     | Gate resistance                                           | f=1MHz                                                                                 |     | 2.3  |      | Ω     |
| <b>SWITCHING PARAMETERS</b>        |                                                           |                                                                                        |     |      |      |       |
| Q <sub>g</sub>                     | Total Gate Charge                                         | V <sub>GS</sub> =10V, V <sub>DS</sub> =320V, I <sub>D</sub> =3.9A                      |     | 5    | 9    | nC    |
| Q <sub>gs</sub>                    | Gate Source Charge                                        |                                                                                        |     | 1.8  |      | nC    |
| Q <sub>gd</sub>                    | Gate Drain Charge                                         |                                                                                        |     | 1.4  |      | nC    |
| t <sub>D(on)</sub>                 | Turn-On DelayTime                                         | V <sub>GS</sub> =10V, V <sub>DS</sub> =200V, I <sub>D</sub> =3.9A, R <sub>G</sub> =25Ω |     | 17   |      | ns    |
| t <sub>r</sub>                     | Turn-On Rise Time                                         |                                                                                        |     | 14   |      | ns    |
| t <sub>D(off)</sub>                | Turn-Off DelayTime                                        |                                                                                        |     | 18   |      | ns    |
| t <sub>f</sub>                     | Turn-Off Fall Time                                        |                                                                                        |     | 9    |      | ns    |
| t <sub>rr</sub>                    | Body Diode Reverse Recovery Time                          | I <sub>F</sub> =3.9A, dI/dt=100A/μs, V <sub>DS</sub> =100V                             |     | 172  |      | ns    |
| Q <sub>rr</sub>                    | Body Diode Reverse Recovery Charge                        | I <sub>F</sub> =3.9A, dI/dt=100A/μs, V <sub>DS</sub> =100V                             |     | 1.1  |      | μC    |

A. The value of R<sub>qJA</sub> is measured with the device in a still air environment with T<sub>A</sub>=25° C.

B. The power dissipation P<sub>D</sub> is based on T<sub>J(MAX)</sub>=150° C in a TO252 package, 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>=150° C.

D. The R<sub>qJA</sub> is the sum of the thermal impedance from junction to case R<sub>qJC</sub> 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 impedance which is measured with the device mounted to a large heatsink, assuming a maximum junction temperature of T<sub>J(MAX)</sub>=150° C.

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. L=60mH, I<sub>AS</sub>=1.9A, V<sub>DD</sub>=150V, R<sub>G</sub>=10Ω, Starting T<sub>J</sub>=25° C.

I. C<sub>o(er)</sub> is a fixed capacitance that gives the same stored energy as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V<sub>(BR)DSS</sub>.

J. C<sub>o(tr)</sub> is a fixed capacitance that gives the same charging time as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V<sub>(BR)DSS</sub>.

THIS PRODUCT HAS BEEN DESIGNED AND QUALIFIED FOR THE CONSUMER MARKET. APPLICATIONS OR USES AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS ARE NOT AUTHORIZED. AOS DOES NOT ASSUME ANY LIABILITY ARISING OUT OF SUCH APPLICATIONS OR USES OF ITS PRODUCTS. AOS RESERVES THE RIGHT TO IMPROVE PRODUCT DESIGN, FUNCTIONS AND RELIABILITY WITHOUT NOTICE.

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

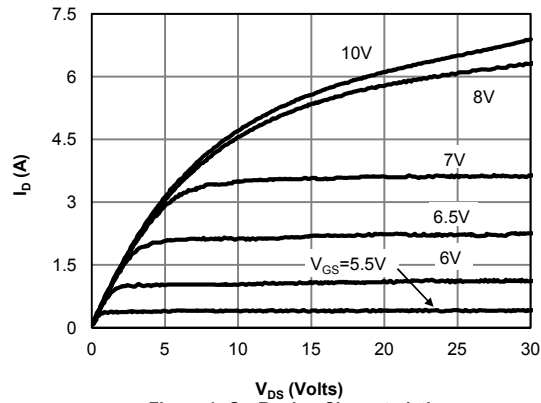


Figure 1: On-Region Characteristics

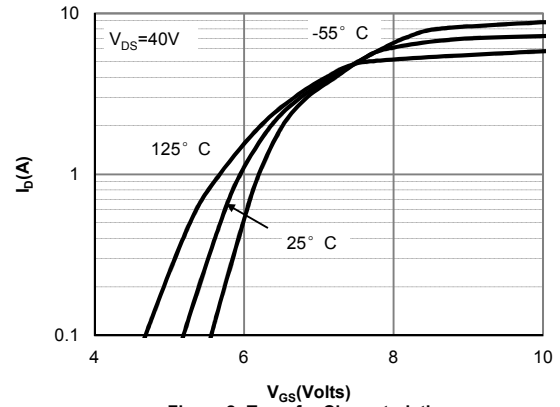


Figure 2: Transfer Characteristics

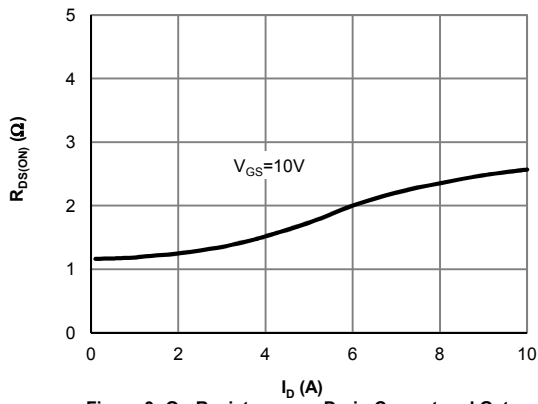


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

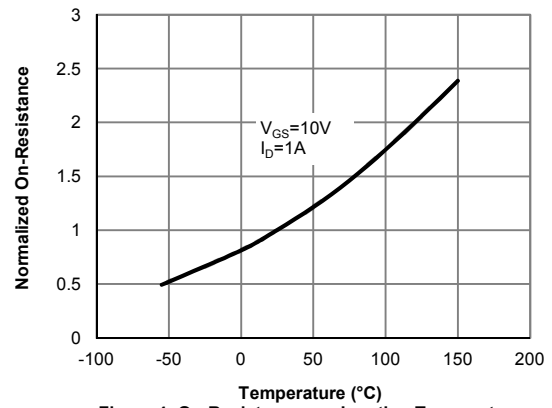


Figure 4: On-Resistance vs. Junction Temperature

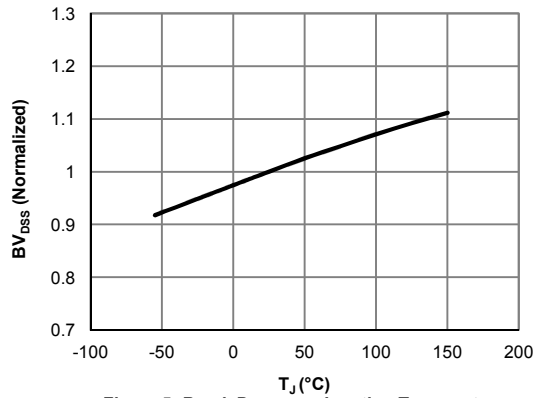


Figure 5: Break Down vs. Junction Temperature

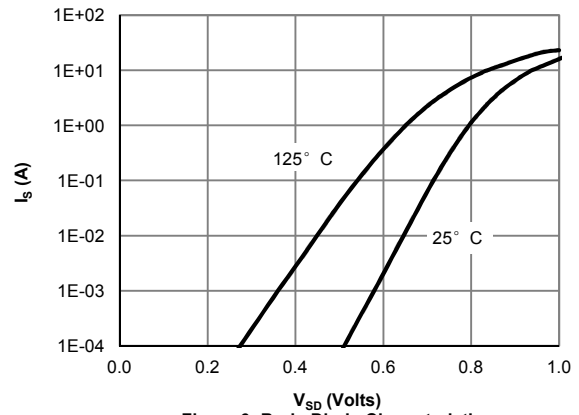
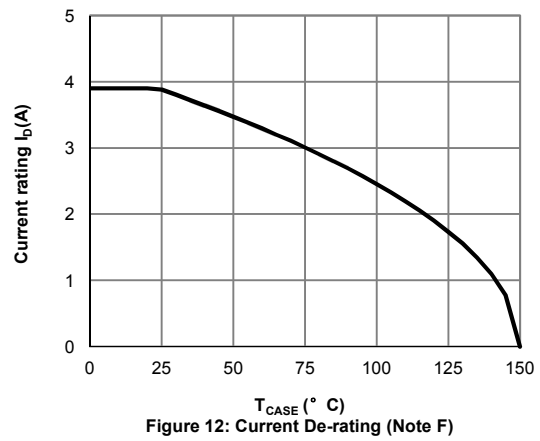
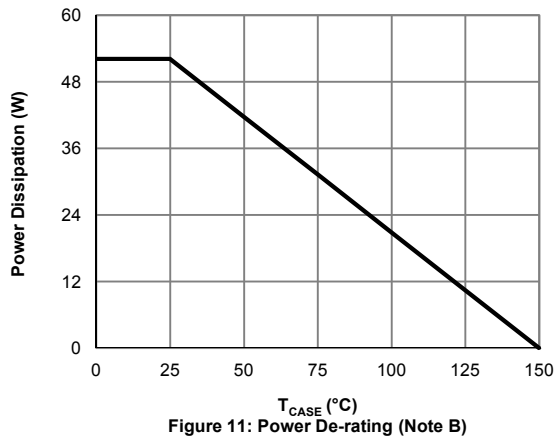
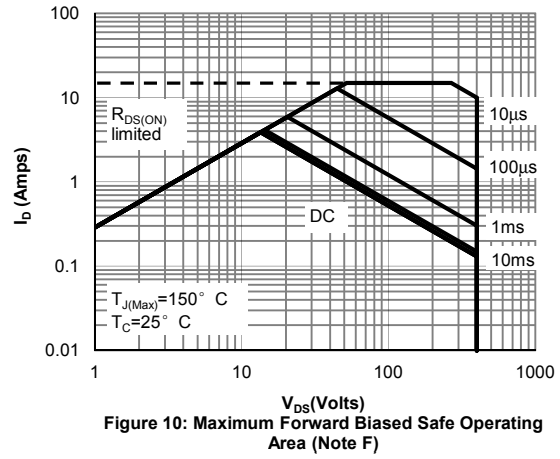
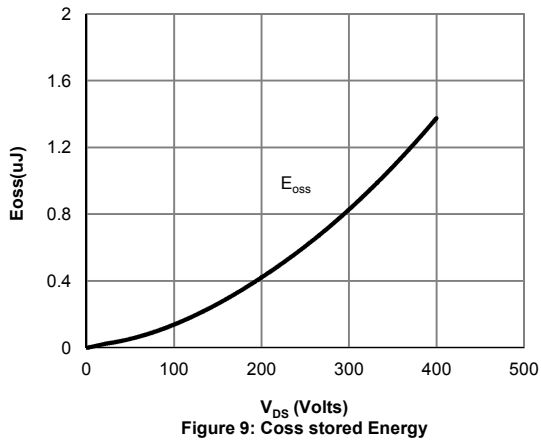
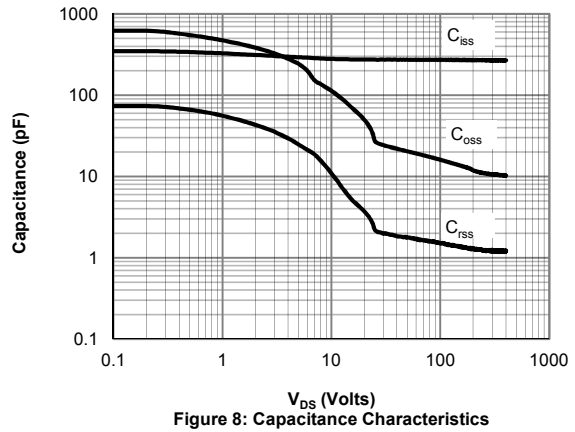
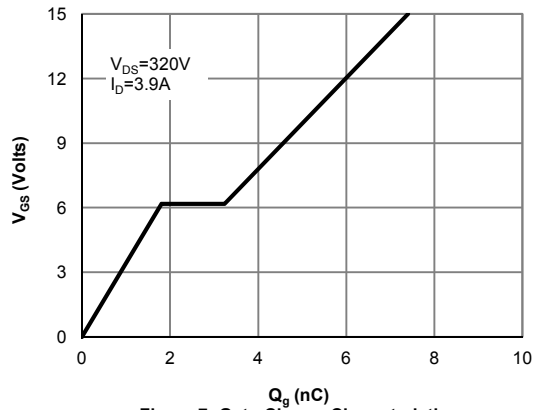


Figure 6: Body-Diode Characteristics

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS



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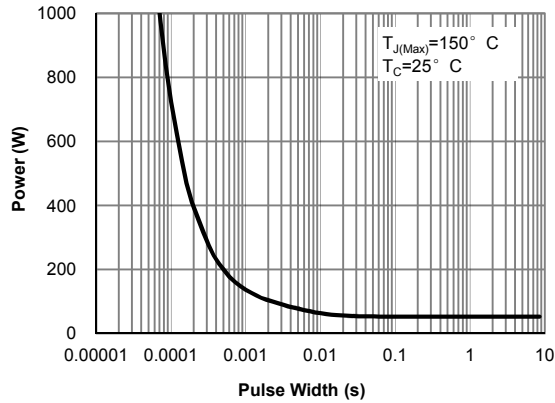


Figure 13: Single Pulse Power Rating Junction-to-Case (Note F)

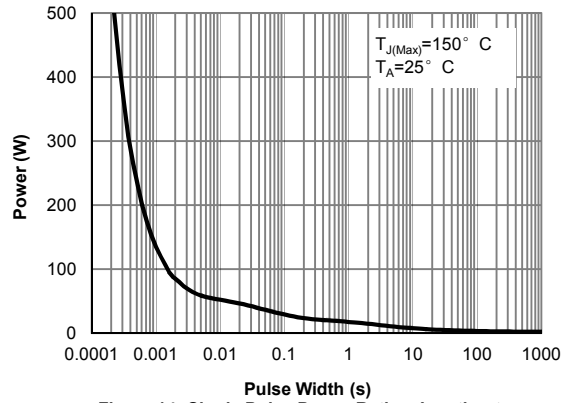


Figure 14: Single Pulse Power Rating Junction-to-Ambient (Note G)

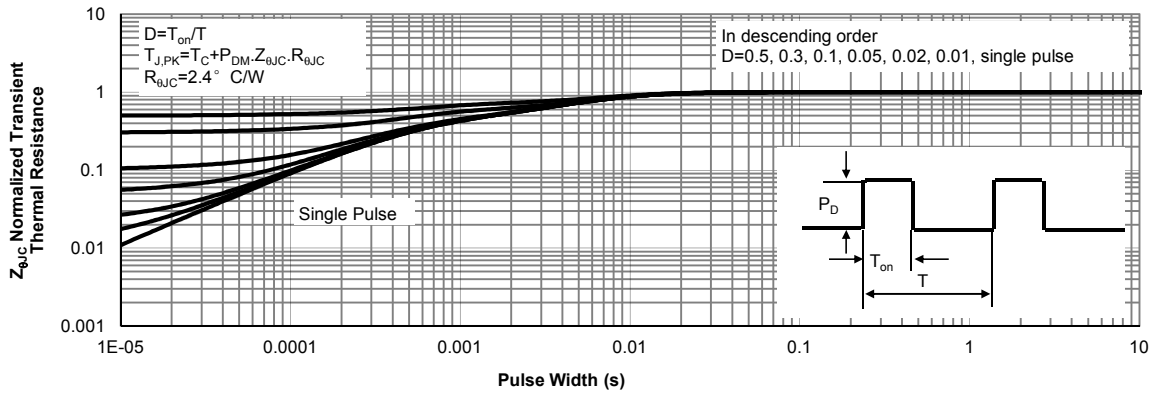


Figure 15: Normalized Maximum Transient Thermal Impedance (Note F)

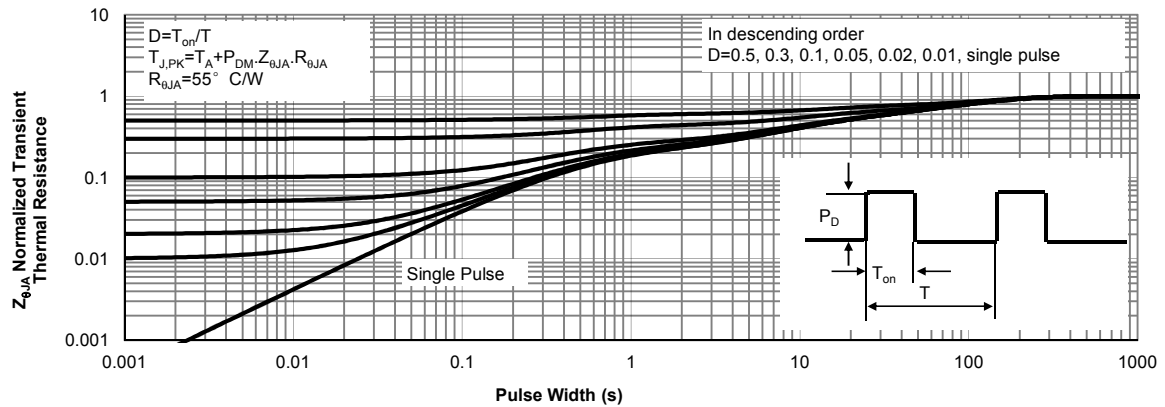
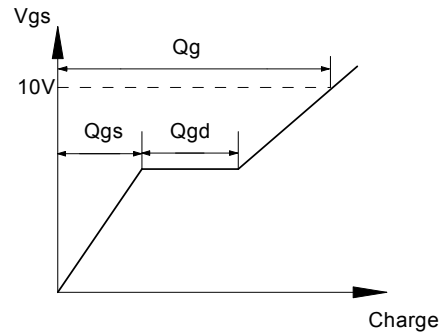
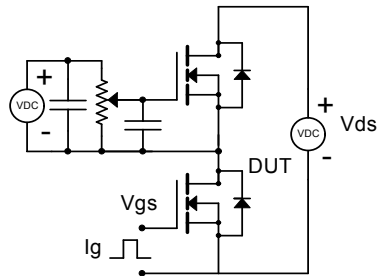
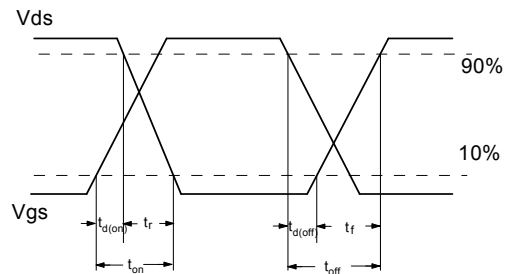
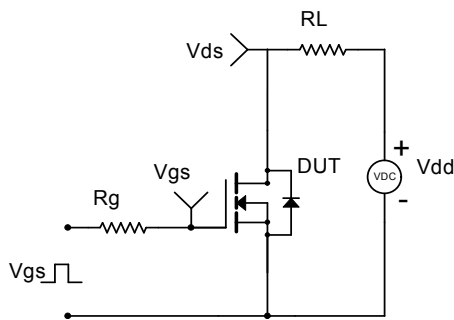


Figure 16: Normalized Maximum Transient Thermal Impedance (Note G)

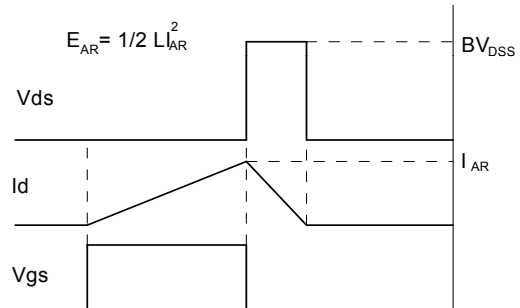
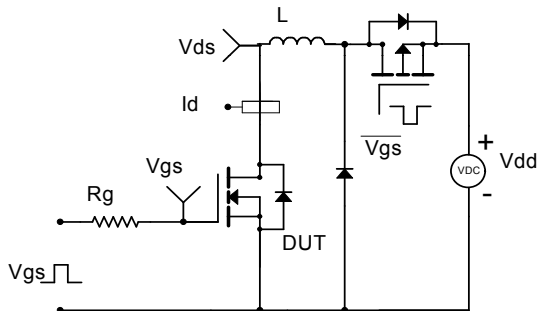
### Gate Charge Test Circuit & Waveform



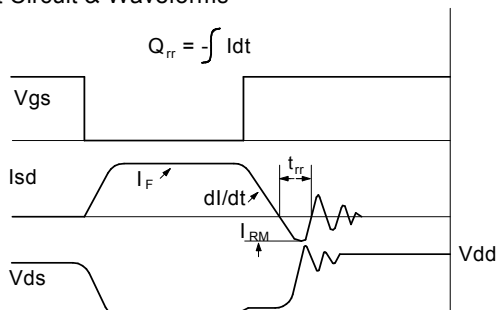
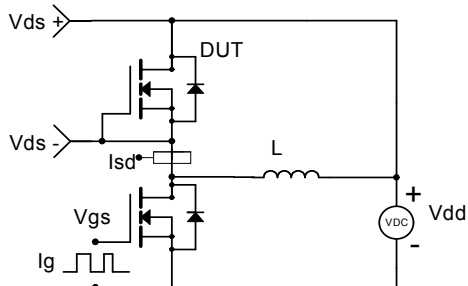
### Resistive Switching Test Circuit & Waveforms



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



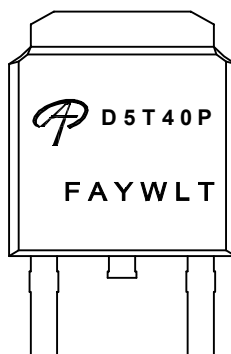
### Diode Recovery Test Circuit & Waveforms





|              |                              |
|--------------|------------------------------|
| Document No. | PD-02166                     |
| Version      | B                            |
| Title        | AOD5T40P Marking Description |

TO252(DPAK) PACKAGE MARKING DESCRIPTION



Green product

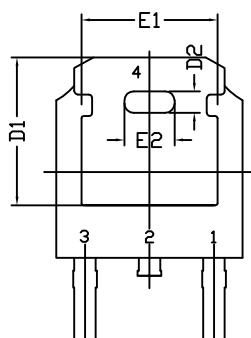
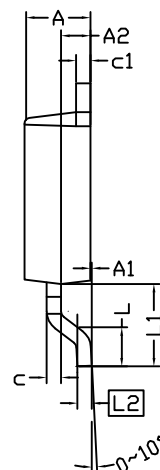
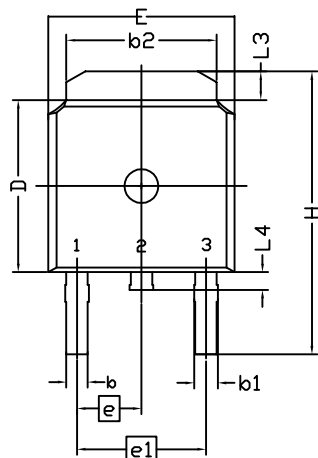
NOTE:

LOGO - AOS Logo  
D5T40P - Part number code  
F - Fab code  
A - Assembly location code  
Y - Year code  
W - Week code  
L&T - Assembly lot code

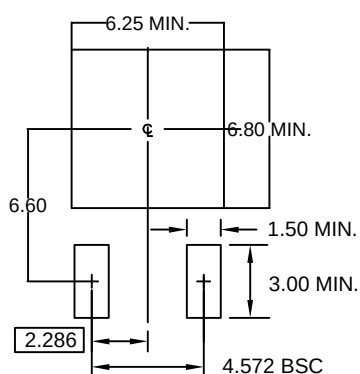
| PART NO. | DESCRIPTION   | CODE   |
|----------|---------------|--------|
| AOD5T40P | Green product | D5T40P |



## TO252(DPAK) PACKAGE OUTLINE



### RECOMMENDED LAND PATTERN



UNIT: mm

#### NOTE

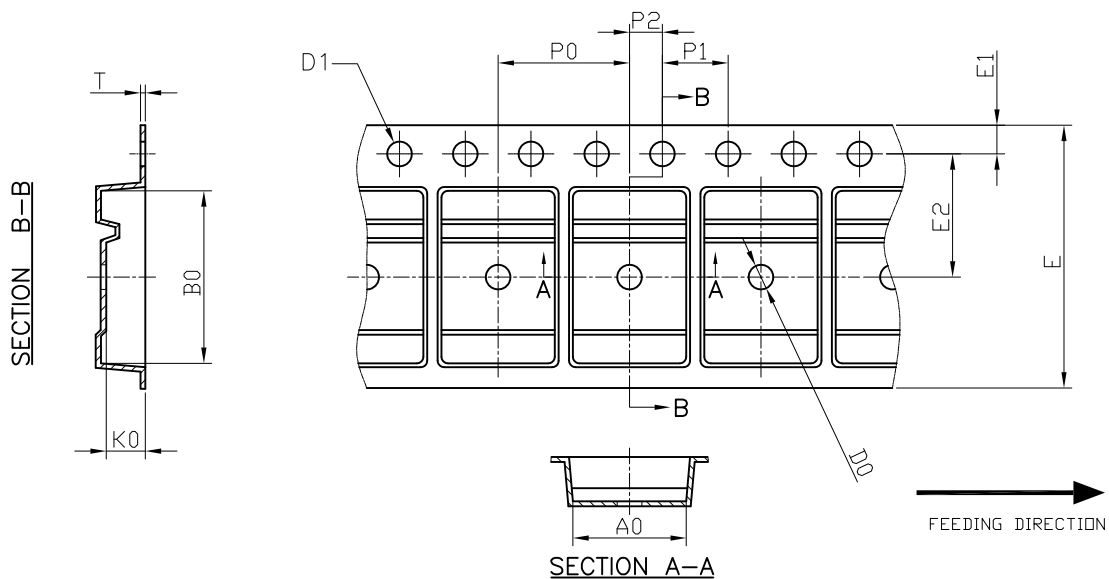
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS. MOLD FLASH SHOULD BE LESS THAN 6 MILS.
2. DIMENSION L IS MEASURED IN GAUGE PLANE
3. TOLERANCE 0.10 mm UNLESS OTHERWISE SPECIFIED
4. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
5. REFER TO JEDEC TO-252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

| 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 |





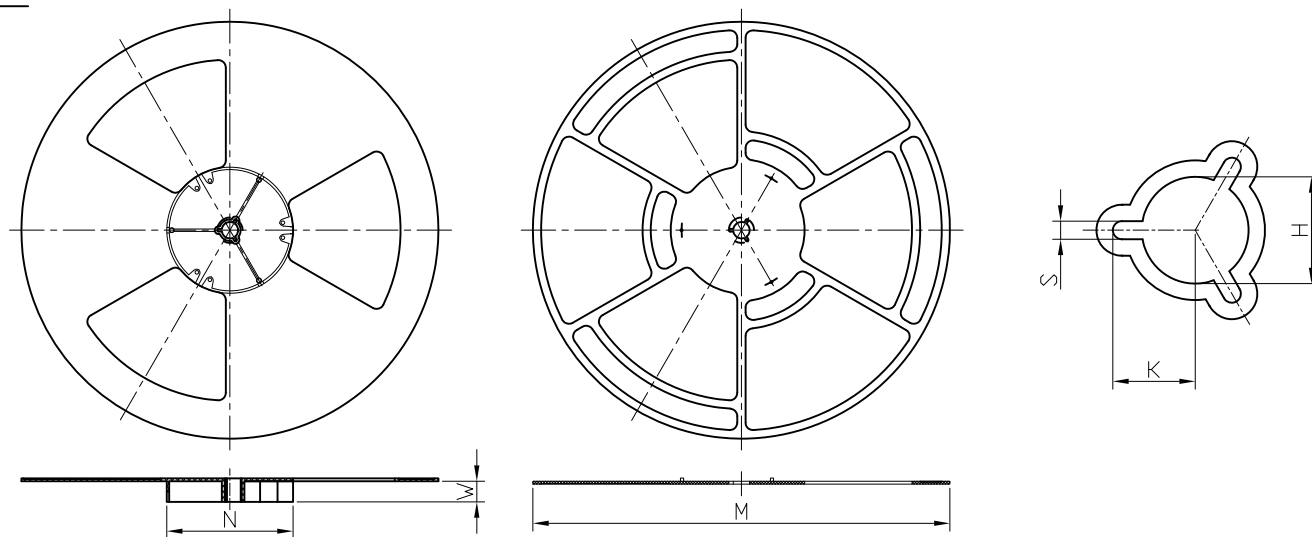
## DPAK Carrier Tape



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 |

## DPAK Reel



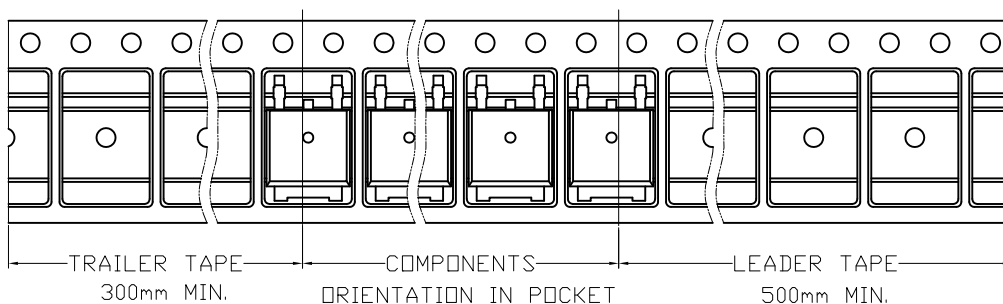
UNIT: MM

| 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 |

## DPAK Tape

Leader / Trailer  
& Orientation

Unit Per Reel:  
2500pcs





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

**AOD5T40P**, rev B

**Plastic Encapsulated Device**

**ALPHA & OMEGA Semiconductor, Inc**

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



This AOS product reliability report summarizes the qualification result for AOD5T40P. 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 AOD5T40P 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.

## Table of Contents:

- I. Product Description
- II. Package and Die information
- III. Reliability Stress Test Summary and Results
- IV. Reliability Evaluation

### I. Product Description:

- Trench Power AlphaMOS-II technology
- Low  $R_{DS(ON)}$
- Low  $C_{iss}$  and  $C_{rss}$
- High Current Capability
- RoHS and Halogen Free Compliant

Details refer to the datasheet.

### II. Die / Package Information:

|                       |                                              |
|-----------------------|----------------------------------------------|
|                       | <b>AOD5T40P</b>                              |
| <b>Process</b>        | Standard sub-micron<br>400V N-Channel MOSFET |
| <b>Package Type</b>   | TO252                                        |
| <b>Lead Frame</b>     | Bare Cu                                      |
| <b>Die Attach</b>     | Solder Paste                                 |
| <b>Bond</b>           | Al & Cu wire                                 |
| <b>Mold Material</b>  | Epoxy resin with silica filler               |
| <b>Moisture Level</b> | Level 1                                      |

### III. 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 | 462 pcs           | 0                  | JESD22-A108        |
| HTRB              | Temp = 150°C ,<br>Vds=80% of Vdsmax                              | 168 / 500 /<br>1000 hours | 462 pcs           | 0                  | JESD22-A108        |
| MSL Precondition  | 168hr 85°C / 85%RH +<br>3 cycle reflow@260°C<br>(MSL 1)          | -                         | 5313 pcs          | 0                  | JESD22-A113        |
| HAST              | 130°C , 85%RH,<br>33.3 psia,<br>Vds = 80% of Vdsmax<br>Up to 42V | 96 hours                  | 924 pcs           | 0                  | JESD22-A110        |
| H3TRB             | 85°C , 85%RH,<br>Vds = 80% of Vdsmax<br>Up to 100V               | 1000 hours                | 924 pcs           | 0                  | JESD22-A101        |
| Autoclave         | 121°C , 29.7psia,<br>RH=100%                                     | 96 hours                  | 924 pcs           | 0                  | JESD22-A102        |
| Temperature Cycle | -65°C to 150°C ,<br>air to air,                                  | 250 / 500<br>cycles       | 924 pcs           | 0                  | JESD22-A104        |
| HTSL              | Temp = 150°C                                                     | 1000 hrs                  | 924 pcs           | 0                  | JESD22-A103        |
| Power Cycling     | $\Delta T_j = 100^\circ\text{C}$                                 | 15000<br>cycles           | 693 pcs           | 0                  | AEC Q101           |

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

### IV. Reliability Evaluation

**FIT rate (per billion): 6.53**

**MTTF = 17473 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** =  $\text{Chi}^2 \times 10^9 / [2 (N) (H) (Af)] = 6.53$

**MTTF** =  $10^9 / \text{FIT} = 17473 \text{ years}$

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

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