ALPHA & OMEGA SEMICONDUCTOR

# AO3485

## 20V P-Channel MOSFET

### General Description

The AO3485 uses advanced trench technology to provide excellent $R_{DS(ON)}$, low gate charge and operation with gate voltages as low as 1.8V. This device is suitable for use as a load switch applications.

• RoHS and Halogen-Free Compliant

### Product Summary

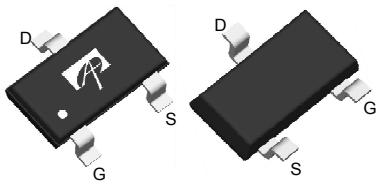
| | |
|---|---|
| $V_{DS}$ | -20V |
| $I_D$ (at $V_{GS}$=-4.5V) | -4A |
| $R_{DS(ON)}$ (at $V_{GS}$= -4.5V) | < 41mΩ |
| $R_{DS(ON)}$ (at $V_{GS}$= -2.5V) | < 53mΩ |
| $R_{DS(ON)}$ (at $V_{GS}$= -1.8V) | < 65mΩ |

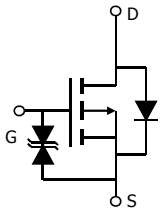
ESD protected HBM Class 2

Green Product

**SOT23**

**Top View** **Bottom View**




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

| Parameter | | Symbol | Maximum | Units |
|---|---|---|---|---|
| Drain-Source Voltage | | $V_{DS}$ | -20 | V |
| Gate-Source Voltage | | $V_{GS}$ | ±8 | V |
| Continuous Drain Current | $T_A$=25°C | $I_D$ | -4 | A |
| | $T_A$=70°C | | -3.5 | |
| Pulsed Drain Current [C] | | $I_{DM}$ | -30 | |
| Power Dissipation [B] | $T_A$=25°C | $P_D$ | 1.5 | W |
| | $T_A$=70°C | | 1 | |
| Junction and Storage Temperature Range | | $T_J$, $T_{STG}$ | -55 to 150 | °C |

**Thermal Characteristics**

| Parameter | | Symbol | Typ | Max | Units |
|---|---|---|---|---|---|
| Maximum Junction-to-Ambient [A] | t ≤ 10s | $R_{\theta JA}$ | 65 | 80 | °C/W |
| Maximum Junction-to-Ambient [A D] | Steady-State | | 85 | 100 | °C/W |
| Maximum Junction-to-Lead | Steady-State | $R_{\theta JL}$ | 43 | 52 | °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 | -20 | | | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$=-20V, $V_{GS}$=0V | | | -1 | µA |
| | | $T_J$=55°C | | | -5 | |
| $I_{GSS}$ | Gate-Body leakage current | $V_{DS}$=0V, $V_{GS}$= ±8V | | | ±10 | µA |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$=$V_{GS}$, $I_D$=-250µA | -0.3 | -0.57 | -0.9 | V |
| $I_{D(ON)}$ | On state drain current | $V_{GS}$=-4.5V, $V_{DS}$=-5V | -30 | | | A |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}$=-4.5V, $I_D$=-4A | | 34 | 41 | mΩ |
| | | $T_J$=125°C | | 49 | 59 | |
| | | $V_{GS}$=-2.5V, $I_D$=-4A | | 42 | 53 | mΩ |
| | | $V_{GS}$=-1.8V, $I_D$=-2A | | 52 | 65 | mΩ |
| | | $V_{GS}$=-1.5V, $I_D$=-1A | | 61 | | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$=-5V, $I_D$=-4A | | 20 | | S |
| $V_{SD}$ | Diode Forward Voltage | $I_S$=-1A,$V_{GS}$=0V | | -0.64 | -1 | V |
| $I_S$ | Maximum Body-Diode Continuous Current | | | | -2 | A |
| **DYNAMIC PARAMETERS** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{GS}$=0V, $V_{DS}$=-10V, f=1MHz | | 751 | | pF |
| $C_{oss}$ | Output Capacitance | | | 115 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 80 | | pF |
| $R_g$ | Gate resistance | $V_{GS}$=0V, $V_{DS}$=0V, f=1MHz | 6 | 13 | 20 | Ω |
| **SWITCHING PARAMETERS** | | | | | | |
| $Q_g$ | Total Gate Charge | $V_{GS}$=-4.5V, $V_{DS}$=-10V, $I_D$=-4A | | 9.3 | 15 | nC |
| $Q_{gs}$ | Gate Source Charge | | | 1 | | nC |
| $Q_{gd}$ | Gate Drain Charge | | | 2.2 | | nC |
| $t_{D(on)}$ | Turn-On DelayTime | $V_{GS}$=-4.5V, $V_{DS}$=-10V, $R_L$=2.5Ω, $R_{GEN}$=3Ω | | 13 | | ns |
| $t_r$ | Turn-On Rise Time | | | 9 | | ns |
| $t_{D(off)}$ | Turn-Off DelayTime | | | 19 | | ns |
| $t_f$ | Turn-Off Fall Time | | | 29 | | ns |
| $t_{rr}$ | Body Diode Reverse Recovery Time | $I_F$=-4A, dI/dt=500A/µs | | 26 | | ns |
| $Q_{rr}$ | Body Diode Reverse Recovery Charge | $I_F$=-4A, dI/dt=500A/µs | | 51 | | nC |

A. The value of $R_{\theta JA}$ is measured with the device mounted on 1in² FR-4 board with 2oz. Copper, in a still air environment with $T_A$ =25° C. The value in any given application depends on the user's specific board design.
B. The power dissipation $P_D$ is based on $T_{J(MAX)}$=150° C, using ≤ 10s junction-to-ambient thermal resistance.
C. Repetitive rating, pulse width limited by junction temperature $T_{J(MAX)}$=150° C. Ratings are based on low frequency and duty cycles to keep initial$T_J$=25° C.
D. The $R_{\theta JA}$ is the sum of the thermal impedance from junction to lead $R_{\theta JL}$ and lead to ambient.
E. The static characteristics in Figures 1 to 6 are obtained using <300µs pulses, duty cycle 0.5% max.
F. These curves are based on the junction-to-ambient thermal impedance which is measured with the device mounted on 1in² FR-4 board with 2oz. Copper, assuming a maximum junction temperature of $T_{J(MAX)}$=150° C. The SOA curve provides a single pulse rating.

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

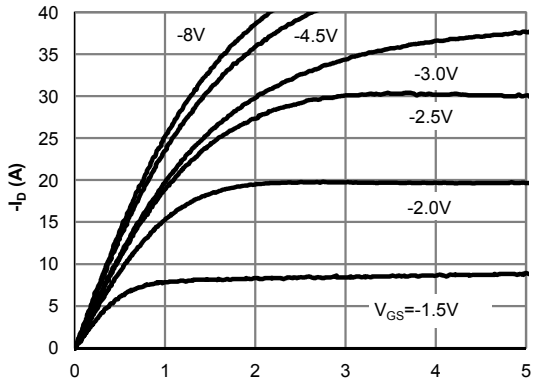



Fig 1: On-Region Characteristics (Note E)

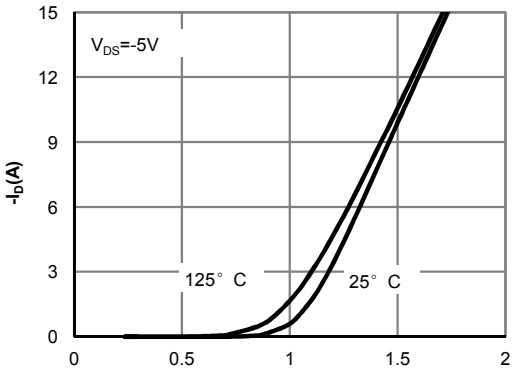



Figure 2: Transfer Characteristics (Note E)

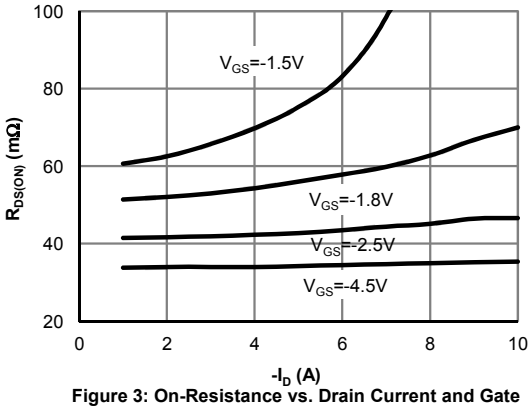



Figure 3: On-Resistance vs. Drain Current and Gate Voltage (Note E)

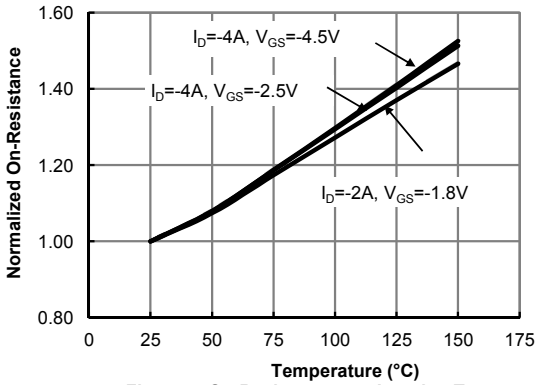



Figure 4: On-Resistance vs. Junction Temperature (Note E)

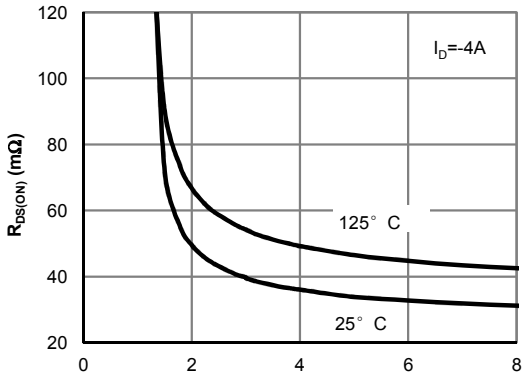



Figure 5: On-Resistance vs. Gate-Source Voltage (Note E)

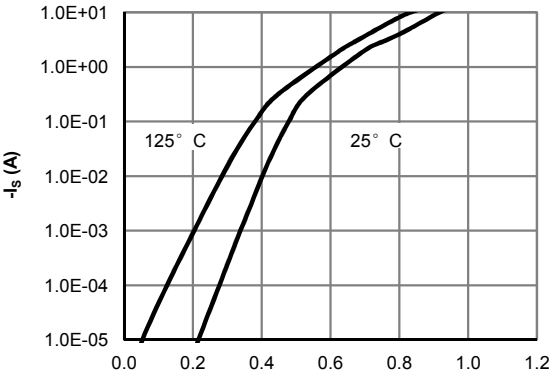



Figure 6: Body-Diode Characteristics (Note E)

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

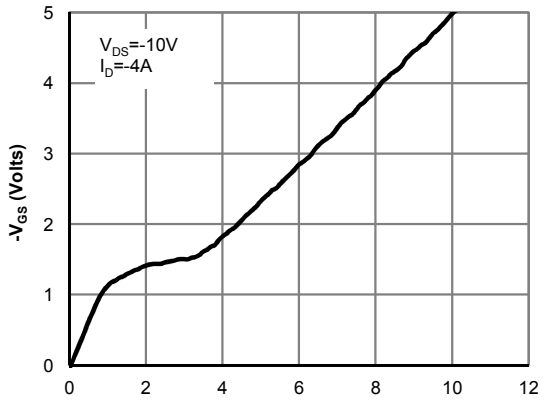



**Figure 7: Gate-Charge Characteristics**

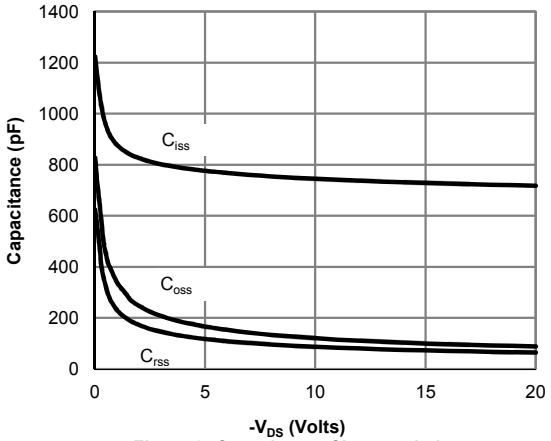



**Figure 8: Capacitance Characteristics**

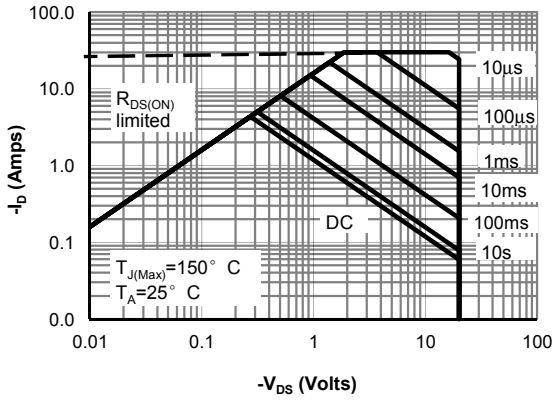



**Figure 9: Maximum Forward Biased Safe Operating Area (Note F)**

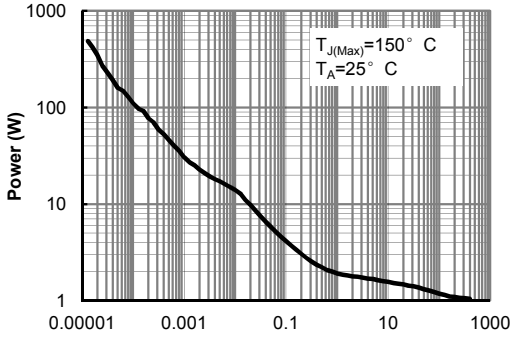



**Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note F)**

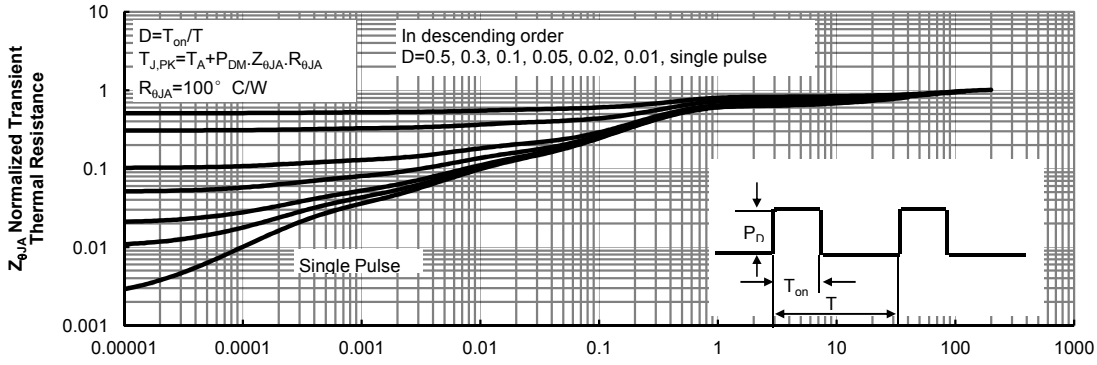
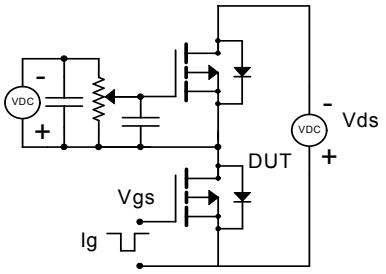
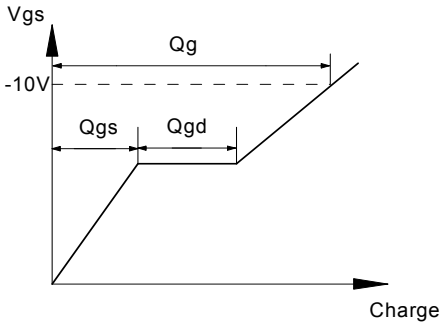


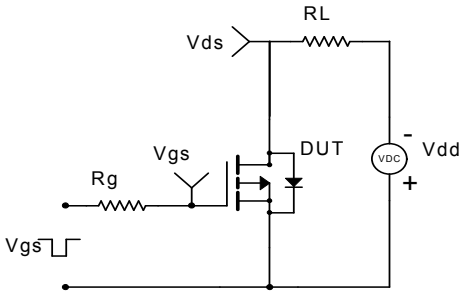

**Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)**

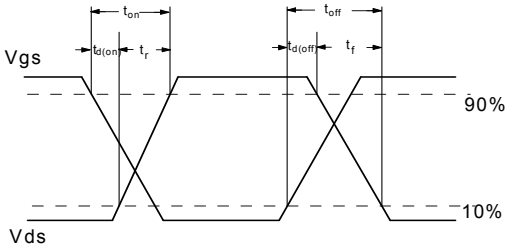
## Gate Charge Test Circuit & Waveform



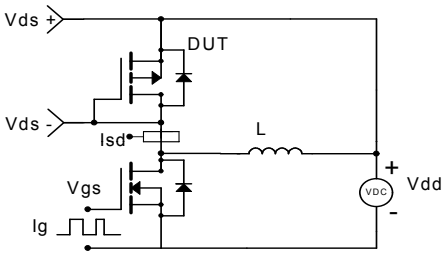



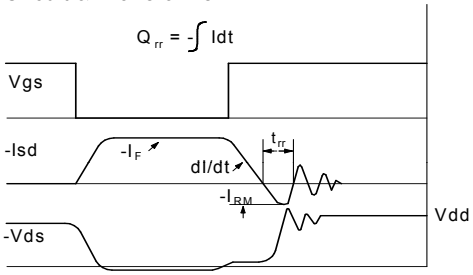

## Resistive Switching Test Circuit & Waveforms




## Diode Recovery Test Circuit & Waveforms

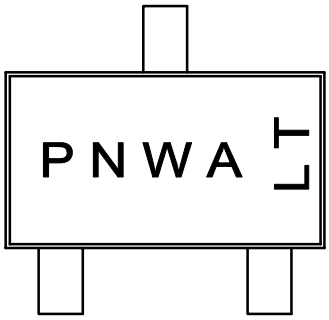


**ALPHA & OMEGA SEMICONDUCTOR**

| Document No. | PD-02363 |
|---|---|
| Version | A |
| Title | AO3485 Marking Description |

SOT-23 PACKAGE MARKING DESCRIPTION

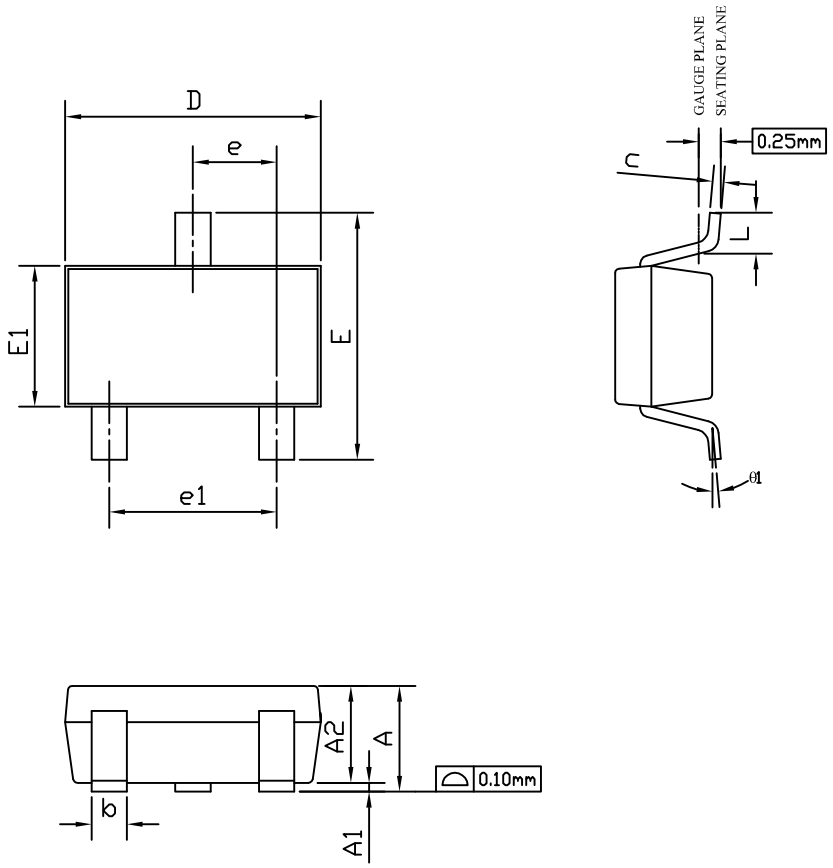



Green product

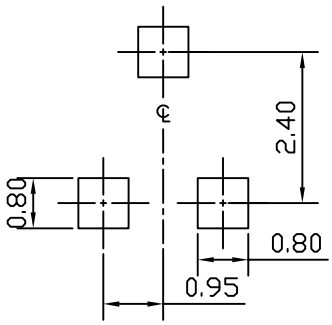
NOTE:
P - Package and product type
N - Last digital of product number
W - Week code
A - Assembly location code
L&T - Assembly lot code

| PART NO. | DESCRIPTION | CODE (PN) |
|---|---|---|
| AO3485 | Green product | CU |

# SOT23 PACKAGE OUTLINE




RECOMMENDED LAND PATTERN




UNIT: mm

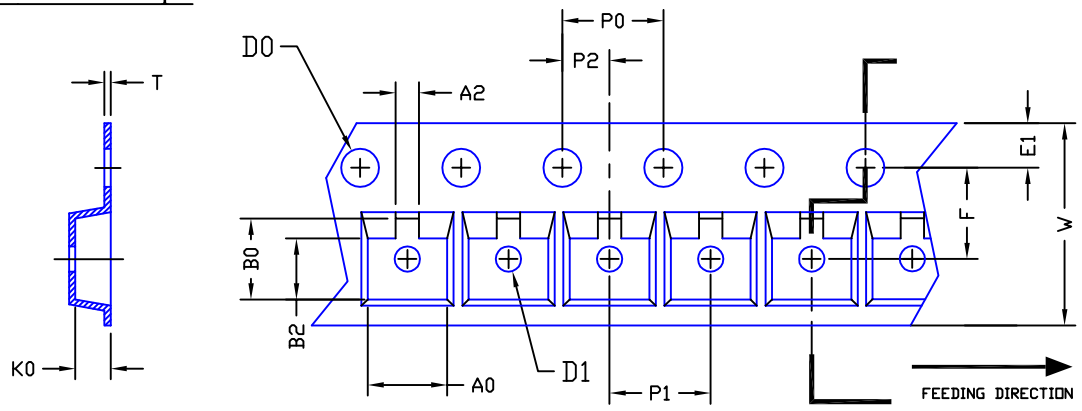
| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.85 | —— | 1.25 | 0.033 | —— | 0.049 |
| A1 | 0.00 | —— | 0.13 | 0.000 | —— | 0.005 |
| A2 | 0.70 | 1.00 | 1.15 | 0.028 | 0.039 | 0.045 |
| b | 0.30 | 0.40 | 0.50 | 0.012 | 0.016 | 0.020 |
| c | 0.08 | 0.13 | 0.20 | 0.003 | 0.005 | 0.008 |
| D | 2.80 | 2.90 | 3.10 | 0.110 | 0.114 | 0.122 |
| E | 2.60 | 2.80 | 3.00 | 0.102 | 0.110 | 0.118 |
| E1 | 1.40 | 1.60 | 1.80 | 0.055 | 0.063 | 0.071 |
| e | 0.95 BSC | | | 0.037 BSC | | |
| e1 | 1.90 BSC | | | 0.075 BSC | | |
| L | 0.30 | —— | 0.60 | 0.012 | —— | 0.024 |
| θ1 | 0° | 5° | 8° | 0° | 5° | 8° |

NOTE
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH OR GATE BURRS.
   MOLD FLASH AT THE NON-LEAD SIDES SHOULD BE LESS THAN 5 MILS EACH.
2. TOLERANCE ±0.100 mm (4 mil) UNLESS OTHERWISE SPECIFIED.
3. DIMENSION L IS MEASURED IN GAUGE PLANE.
4. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS
   ARE NOT NECESSARILY EXACT.
5. ALL DIMENSIONS ARE IN MILLIMETERS.

ALPHA & OMEGA
SEMICONDUCTOR, LTD.

# SOT23-3L Tape and Reel Data

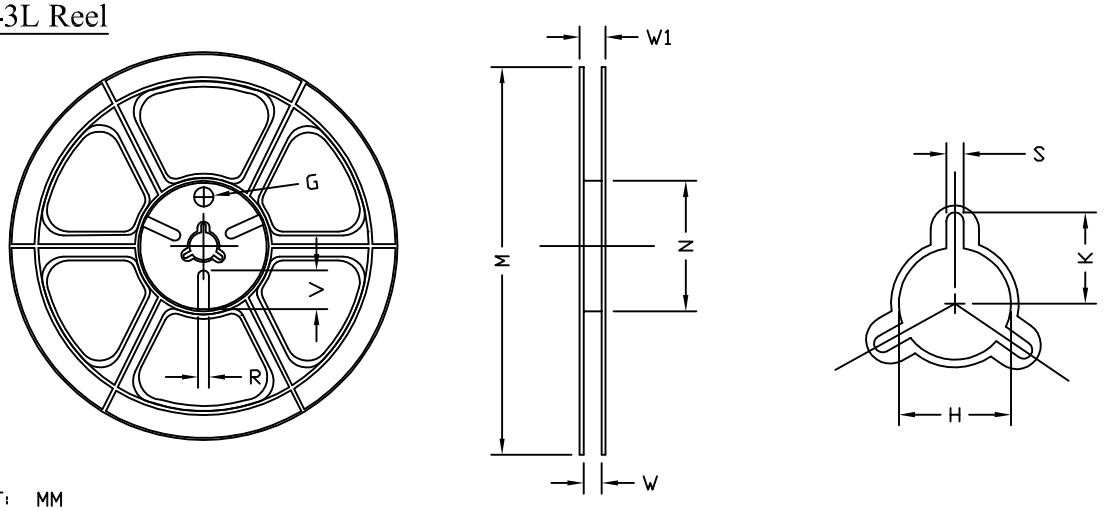
## SOT23-3L Carrier Tape




UNIT: MM

| PACKAGE | A0 | B0 | K0 | D0 | D1 | W | E1 | F | P0 | P1 | P2 | T | A2 | B2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOT23-3L (8 mm) | 3.05-3.40 | 3.00-3.38 | 1.20- 1.47 | 1.55 ±0.05 | 1.00 ±0.25 | 8.00 ±0.30 | 1.75 ±0.10 | 3.50 ±0.05 | 4.00 ±0.10 | 4.00 ±0.10 | 2.00 ±0.05 | 0.18 -0.25 | 0.84-1.24 | 2.29-2.69 |

## SOT23-3L Reel



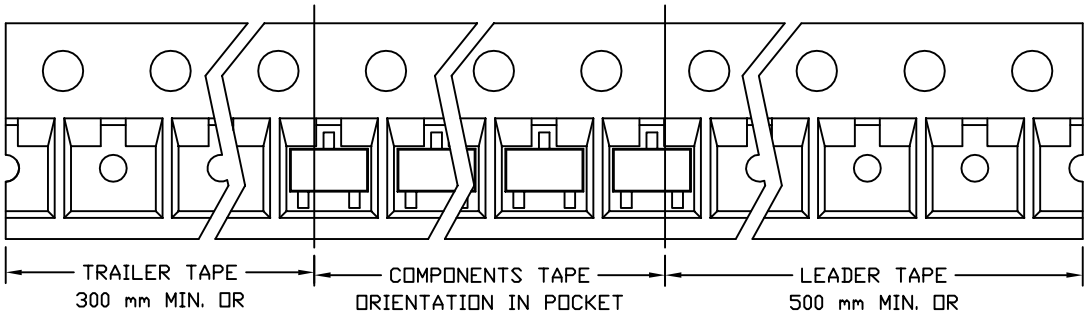

UNIT: MM

| TAPE SIZE | REEL SIZE | M | N | W | W1 | H | K | S | G | R | V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 mm | ø178 | ø178.00 ±1.00 | ø54.00 ±0.50 | 9.00 ±0.30 | 11.40 ±1.00 | ø13.00 +0.50 -0.20 | 10.60 | 2.00 ±0.50 | ø9.00 | 5.00 | 18.00 |

## SOT23-3L Tape

Leader / Trailer & Orientation

Unit Per Reel: 3000pcs



ALPHA & OMEGA SEMICONDUCTOR

This AOS product reliability report summarizes the qualification result for AO3485. 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 AO3485 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 , Vgs=100% of Vgsmax** | **168 / 500 / 1000 hours** | **924 pcs** | **0** | **JESD22-A108** |
| **HTRB** | **Temp = 150°C , Vds=80% of Vdsmax** | **168 / 500 / 1000 hours** | **924 pcs** | **0** | **JESD22-A108** |
| **Precondition** (Note A) | **168hr 85°C / 85%RH + 3 cycle reflow@260°C (MSL 1)** | **-** | **5082 pcs** | **0** | **JESD22-A113** |
| **HAST** | **130°C , 85%RH, 33.3 psia, Vds = 80% of Vdsmax** | **96 hours** | **924 pcs** | **0** | **JESD22-A110** |
| **H3TRB** | **85°C , 85%RH, Vds = 80% of Vdsmax** | **1000 hours** | **693 pcs** | **0** | **JESD22-A101** |
| **Autoclave** | **121°C , 29.7psia, RH=100%** | **96 hours** | **924 pcs** | **0** | **JESD22-A102** |
| **Temperature Cycle** | **-65°C to 150°C , air to air,** | **1000 cycles** | **924 pcs** | **0** | **JESD22-A104** |
| **HTSL** | **Temp = 150°C** | **1000 hours** | **924 pcs** | **0** | **JESD22-A103** |
| **Power Cycling** | **$\Delta$ Tj = 100°C** | **15000 cycles** | **693 pcs** | **0** | **AEC Q101** |

**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** = $Chi^2 \times 10^9$ **/ [**2 (N) (H) (Af)**] =** 1.91
**MTTF =** $10^9$ / FIT = 59839 years
**Chi²** = 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**] = **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** | **259** | **87** | **32** | **13** | **5.64** | **2.59** | **1** |

**Tj s** = Stressed junction temperature in degree (Kelvin), K = C+273.16
**Tj u** =The use junction temperature in degree (Kelvin), K = C+273.16
**k** = Boltzmann's constant, 8.617164 X $10^{-5}$eV / K