ALPHA & OMEGA SEMICONDUCTOR, INC.

July 2001

# AO3401
# P-Channel Enhancement Mode Field Effect Transistor

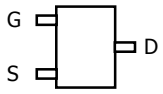
## General Description

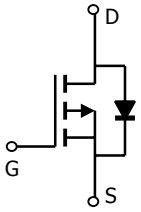
The AO3401 uses advanced trench technology to provide excellent $R_{DS(ON)}$, low gate charge and operation with gate voltages as low as 2.5V. This device is suitable for use as a load switch or in PWM applications.

## Features

$V_{DS}$ (V) = -30V
$I_D$ = -4.2 A
$R_{DS(ON)}$ < 50mΩ ($V_{GS}$ = -10V)
$R_{DS(ON)}$ < 65mΩ ($V_{GS}$ = -4.5V)
$R_{DS(ON)}$ < 120mΩ ($V_{GS}$ = -2.5V)

**TO-236**
**(SOT-23)**
**Top View**




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

| Parameter | | Symbol | Maximum | Units |
|---|---|---|---|---|
| Drain-Source Voltage | | $V_{DS}$ | -30 | V |
| Gate-Source Voltage | | $V_{GS}$ | ±12 | V |
| Continuous Drain Current [A] | $T_A$=25°C | $I_D$ | -4.2 | A |
| | $T_A$=70°C | | -3.5 | |
| Pulsed Drain Current [B] | | $I_{DM}$ | -30 | |
| Power Dissipation [A] | $T_A$=25°C | $P_D$ | 1.4 | 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 | 90 | °C/W |
| Maximum Junction-to-Ambient [A] | Steady-State | | 85 | 125 | °C/W |
| Maximum Junction-to-Lead [C] | Steady-State | $R_{\theta JL}$ | 43 | 60 | °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 | -30 | | | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$=-24V, $V_{GS}$=0V | | | -1 | µA |
| | | $T_J$=55°C | | | -5 | |
| $I_{GSS}$ | Gate-Body leakage current | $V_{DS}$=0V, $V_{GS}$=±12V | | | ±100 | nA |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$=$V_{GS}$ $I_D$=-250µA | -0.7 | -1 | -1.3 | V |
| $I_{D(ON)}$ | On state drain current | $V_{GS}$=-4.5V, $V_{DS}$=-5V | -25 | | | A |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}$=-10V, $I_D$=-4.2A | | 42 | 50 | mΩ |
| | | $T_J$=125°C | | | 75 | |
| | | $V_{GS}$=-4.5V, $I_D$=-4A | | 53 | 65 | mΩ |
| | | $V_{GS}$=-2.5V, $I_D$=-1A | | 80 | 120 | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$=-5V, $I_D$=-5A | 7 | 11 | | S |
| $V_{SD}$ | Diode Forward Voltage | $I_S$=-1A,$V_{GS}$=0V | | -0.75 | -1 | V |
| $I_S$ | Maximum Body-Diode Continuous Current | | | | -2.2 | A |
| **DYNAMIC PARAMETERS** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{GS}$=0V, $V_{DS}$=-15V, f=1MHz | | 954 | | pF |
| $C_{oss}$ | Output Capacitance | | | 115 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 77 | | pF |
| $R_g$ | Gate resistance | $V_{GS}$=0V, $V_{DS}$=0V, f=1MHz | | 6 | | Ω |
| **SWITCHING PARAMETERS** | | | | | | |
| $Q_g$ | Total Gate Charge | $V_{GS}$=-4.5V, $V_{DS}$=-15V, $I_D$=-4A | | 9.4 | | nC |
| $Q_{gs}$ | Gate Source Charge | | | 2 | | nC |
| $Q_{gd}$ | Gate Drain Charge | | | 3 | | nC |
| $t_{D(on)}$ | Turn-On DelayTime | $V_{GS}$=-10V, $V_{DS}$=-15V, $R_L$=3.6Ω, $R_{GEN}$=6Ω | | 6.3 | | ns |
| $t_r$ | Turn-On Rise Time | | | 3.2 | | ns |
| $t_{D(off)}$ | Turn-Off DelayTime | | | 38.2 | | ns |
| $t_f$ | Turn-Off Fall Time | | | 12 | | ns |
| $t_{rr}$ | Body Diode Reverse Recovery Time | $I_F$=-4A, dI/dt=100A/µs | | 20.2 | | ns |
| $Q_{rr}$ | Body Diode Reverse Recovery Charge | $I_F$=-4A, dI/dt=100A/µs | | 11.2 | | 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 value in any a given application depends on the user's specific board design. The current rating is based on the t≤ 10s thermal resistance rating.

B: Repetitive rating, pulse width limited by junction temperature.

C. The $R_{\theta JA}$ is the sum of the thermal impedence from junction to lead $R_{\theta JL}$ and lead to ambient.

D. The static characteristics in Figures 1 to 6,12,14 are obtained using 80µs pulses, duty cycle 0.5% max.

E. 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. The SOA curve provides a single pulse rating.

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

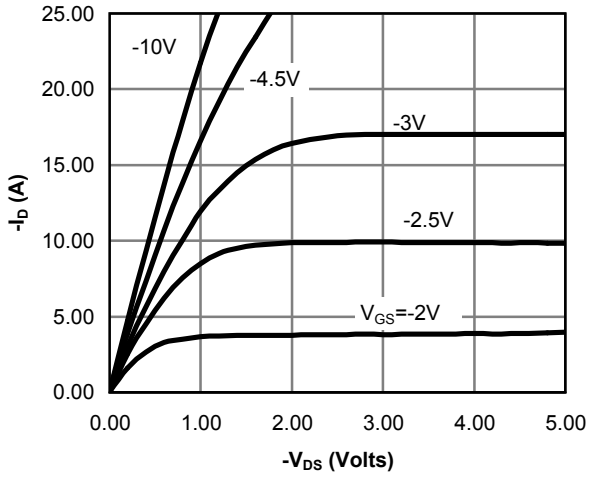



**Fig 1: On-Region Characteristics**

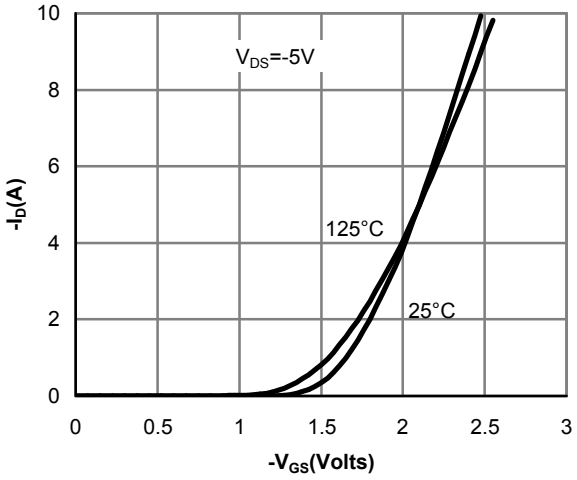



**Figure 2: Transfer Characteristics**

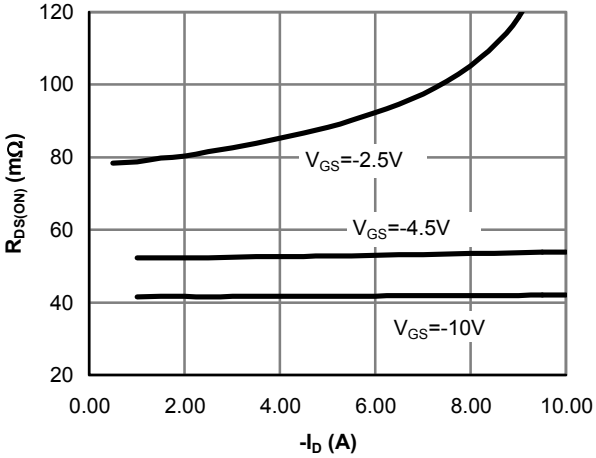



**Figure 3: On-Resistance vs. Drain Current and Gate Voltage**

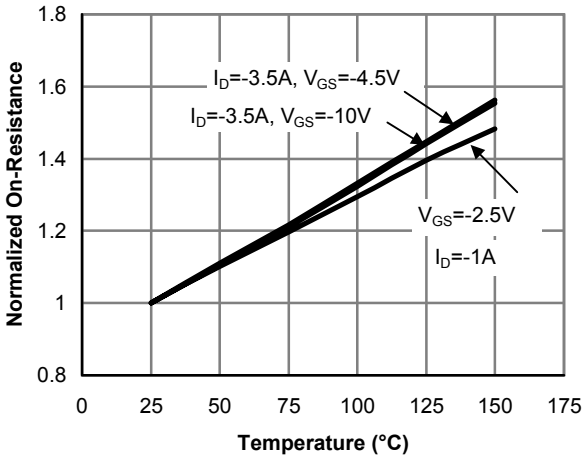



**Figure 4: On-Resistance vs. Junction Temperature**

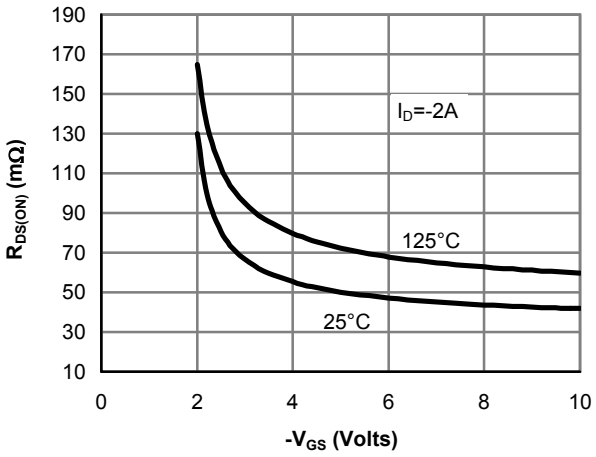



**Figure 5: On-Resistance vs. Gate-Source Voltage**

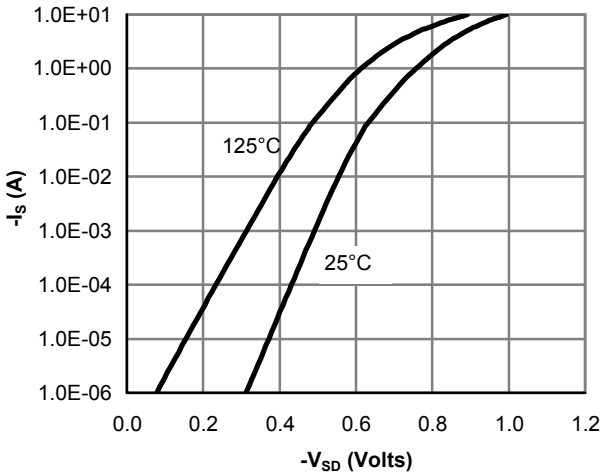



**Figure 6: Body-Diode Characteristics**

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

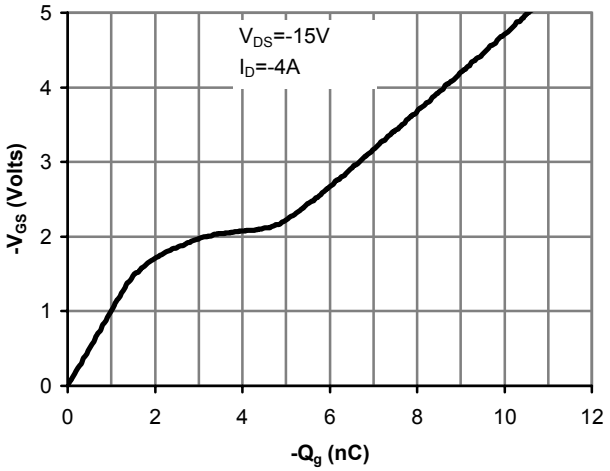



**Figure 7: Gate-Charge Characteristics**

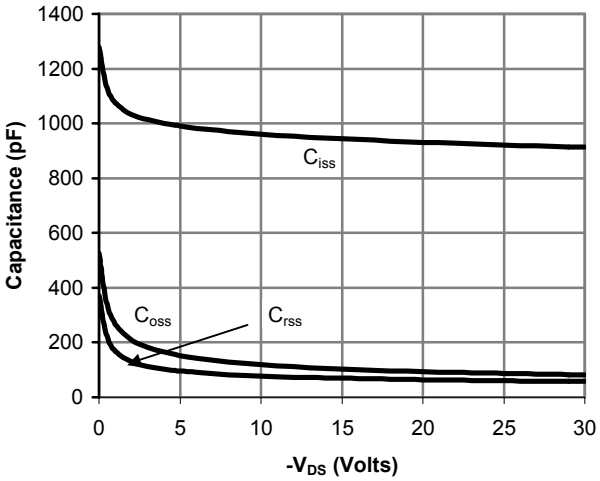



**Figure 8: Capacitance Characteristics**

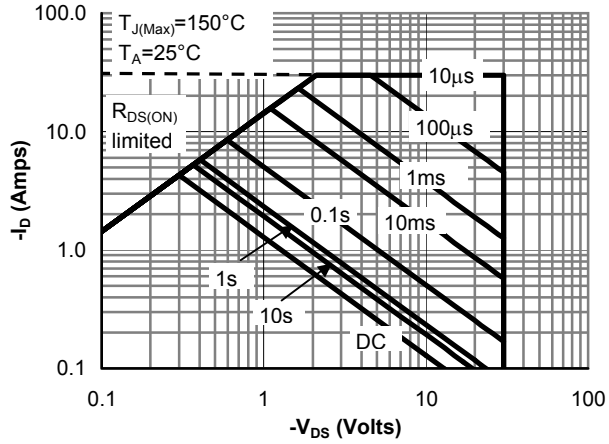



**Figure 9: Maximum Forward Biased Safe Operating Area (Note E)**

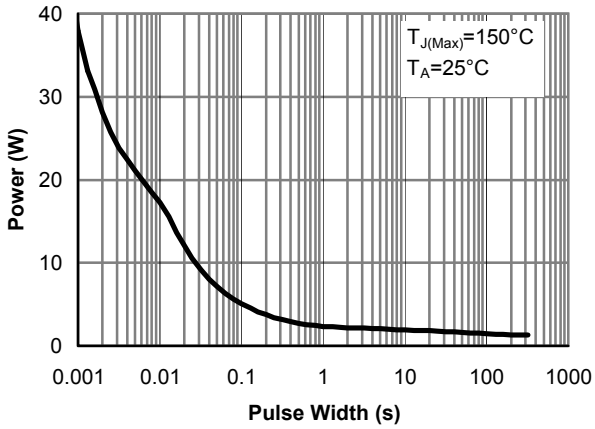



**Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)**

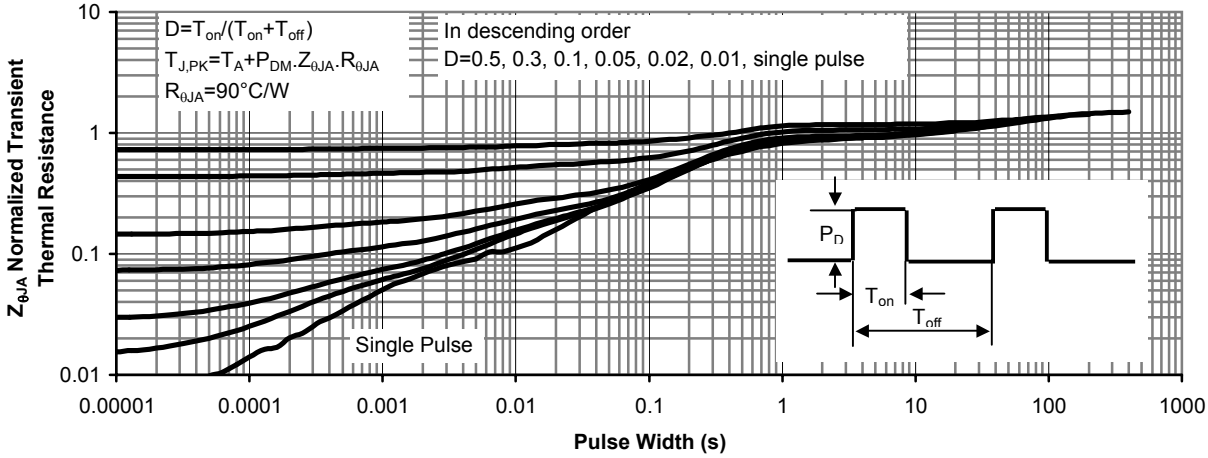



**Figure 11: Normalized Maximum Transient Thermal Impedance**

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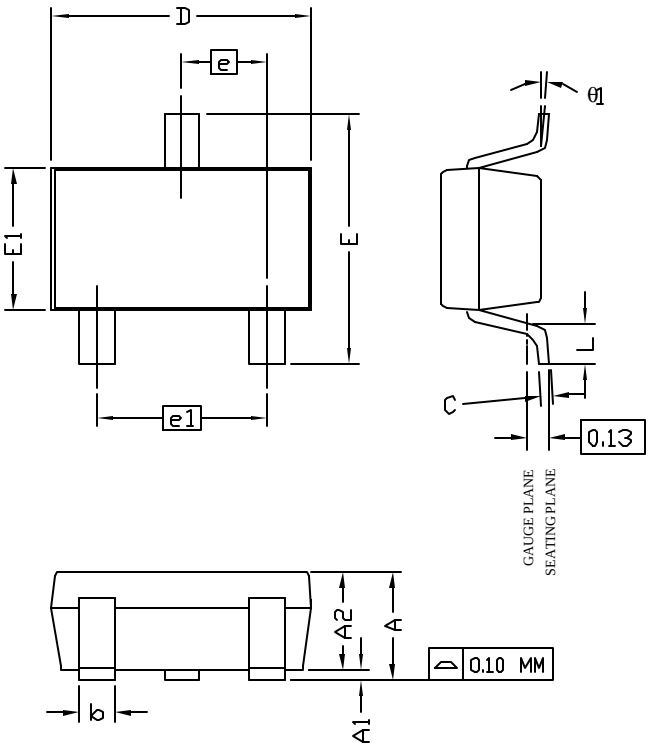
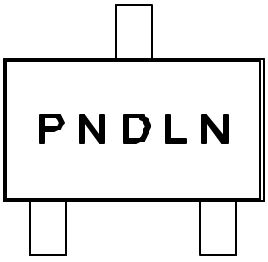
# SOT-23 Package Data




| SYMBOLS | DIMENSIONS IN MILLIMETERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 1.00 | —— | 1.25 |
| A1 | 0.00 | —— | 0.10 |
| A2 | 1.00 | 1.10 | 1.15 |
| b | 0.35 | 0.40 | 0.50 |
| C | 0.10 | 0.15 | 0.25 |
| D | 2.80 | 2.90 | 3.04 |
| E | 2.60 | 2.80 | 2.95 |
| E1 | 1.40 | 1.60 | 1.80 |
| e | —— | 0.95 BSC | —— |
| e1 | —— | 1.90 BSC | —— |
| L | 0.40 | —— | 0.60 |
| θ1 | 1° | 5° | 8° |

NOTE:
1. LEAD FINISH: 150 MICROINCHES ( 3.8 um) MIN. THICKNESS OF Tin/Lead (SOLDER) PLATED ON LEAD
2. TOLERANCE ±0.100 mm (4 mil) UNLESS OTHERWISE SPECIFIED
3. COPLANARITY : 0.1000 mm
4. DIMENSION L IS MEASURED IN GAGE PLANE

PACKAGE MARKING DESCRIPTION

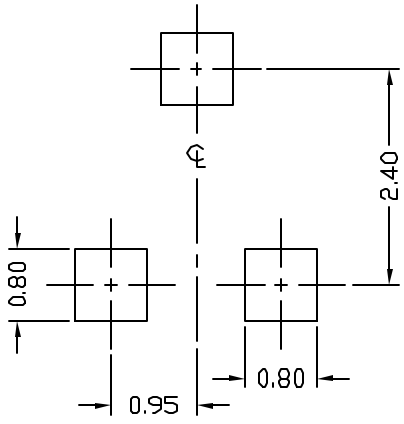



NOTE:
P N - PART NUMBER CODE.
D - YAER AND WEEK CODE.
L N - ASSEMBLY LOT CODE, FAB AND ASSEMBLY LOCATION CODE.

SOT-23 PART NO. CODE

| PART NO. | CODE |
|---|---|
| AO3400 | A0 |
| AO3401 | A1 |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

RECOMMENDED LAND PATTERN



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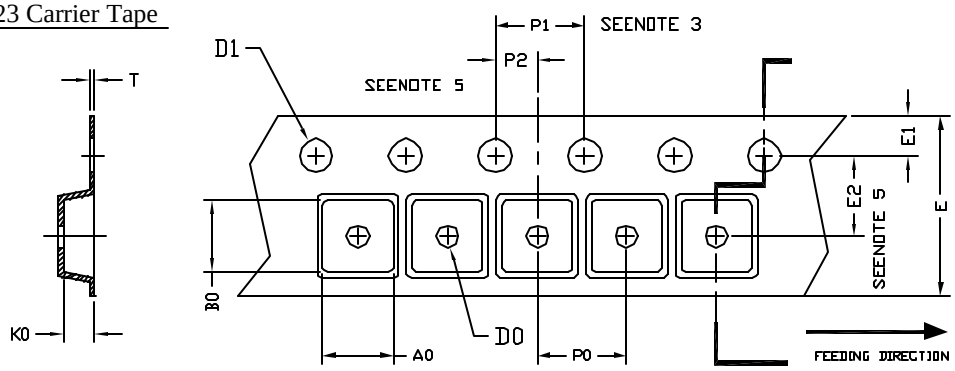
# SOT-23 Tape and Reel Data

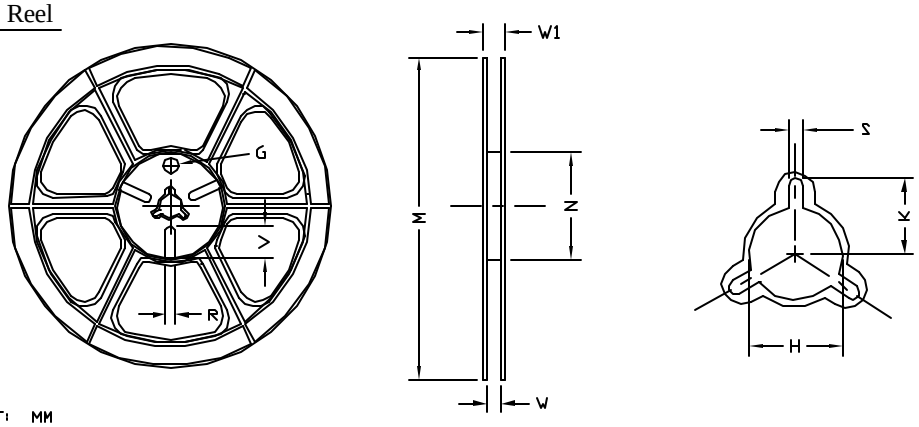
## SOT-23 Carrier Tape




UNIT: MM

| PACKAGE | A0 | B0 | K0 | D0 | D1 | E | E1 | E2 | P0 | P1 | P2 | T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOT-23 (8 mm) | 3.15 ±0.10 | 3.20 ±0.10 | 1.40 ±0.10 | 1.00 MIN | 1.50 +0.10 | 8.00 ±0.30 | 1.75 ±0.10 | 3.50 ±0.05 | 4.00 ±0.10 | 4.00 ±0.10 | 2.00 ±0.05 | 0.25 ±0.05 |

## SOT-23 Reel




UNIT: MM

| TAPE SIZE | REEL SIZE | M | N | W | W1 | H | K | S | G | R | V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 mm | ø180 | ø180.00 ±0.50 | ø60.50 | 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 |

## SOT-23 Tape

Leader / Trailer & Orientation