



**ALPHA & OMEGA**  
SEMICONDUCTOR, INC.

June 2002

## AO4413

### P-Channel Enhancement Mode Field Effect Transistor

#### General Description

The AO4413 uses advanced trench technology to provide excellent  $R_{DS(ON)}$ , and ultra-low low gate charge with a 25V gate rating. This device is suitable for use as a load switch or in PWM applications.

#### Features

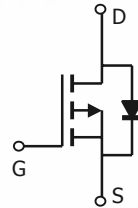
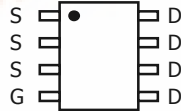
$V_{DS}$  (V) = -30V

$I_D$  = -15A

$R_{DS(ON)} < 7m\Omega$  ( $V_{GS} = -20V$ )

$R_{DS(ON)} < 8.5m\Omega$  ( $V_{GS} = -10V$ )

SOIC-8  
Top View



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

| Parameter                              | Symbol         | Maximum                | Units            |
|----------------------------------------|----------------|------------------------|------------------|
| Drain-Source Voltage                   | $V_{DS}$       | -30                    | V                |
| Gate-Source Voltage                    | $V_{GS}$       | $\pm 25$               | V                |
| Continuous Drain Current <sup>A</sup>  | $I_D$          | $T_A=25^\circ\text{C}$ | -15              |
|                                        |                | $T_A=70^\circ\text{C}$ | -12.8            |
| Pulsed Drain Current <sup>B</sup>      | $I_{DM}$       | -80                    | A                |
| Power Dissipation <sup>A</sup>         | $P_D$          | $T_A=25^\circ\text{C}$ | 3                |
|                                        |                | $T_A=70^\circ\text{C}$ | 2.1              |
| Junction and Storage Temperature Range | $T_J, T_{STG}$ | -55 to 150             | $^\circ\text{C}$ |

#### Thermal Characteristics

| Parameter                                | Symbol          | Typ          | Max | Units              |
|------------------------------------------|-----------------|--------------|-----|--------------------|
| Maximum Junction-to-Ambient <sup>A</sup> | $R_{\theta JA}$ | $t \leq 10s$ | 26  | $^\circ\text{C/W}$ |
| Maximum Junction-to-Ambient <sup>A</sup> |                 | Steady-State | 40  | $^\circ\text{C/W}$ |
| Maximum Junction-to-Lead <sup>C</sup>    | $R_{\theta JL}$ | Steady-State | 50  | $^\circ\text{C/W}$ |
|                                          |                 |              | 14  | $^\circ\text{C/W}$ |



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                                                 | -30  |            |          | V     |
| I <sub>DSS</sub>            | Zero Gate Voltage Drain Current       | V <sub>DS</sub> =-24V, 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> =±25V                                                  |      |            | ±100     | nA    |
| V <sub>GS(th)</sub>         | Gate Threshold Voltage                | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =-250μA                                   | -1.5 | -2.6       | -3.5     | V     |
| I <sub>D(ON)</sub>          | On state drain current                | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-5V                                                 | 60   |            |          | A     |
| R <sub>DS(ON)</sub>         | Static Drain-Source On-Resistance     | V <sub>GS</sub> =-20V, I <sub>D</sub> =-15A<br>T <sub>J</sub> =125°C                        |      | 5.8<br>7.2 | 7<br>8.7 | mΩ    |
|                             |                                       | V <sub>GS</sub> =-10V, I <sub>D</sub> =-15A                                                 |      | 7.2        | 8.5      | mΩ    |
|                             |                                       | V <sub>GS</sub> =-6V, I <sub>D</sub> =-10A                                                  |      | 10.4       |          | mΩ    |
|                             |                                       |                                                                                             |      |            |          |       |
| g <sub>FS</sub>             | Forward Transconductance              | V <sub>DS</sub> =-5V, I <sub>D</sub> =-15A                                                  |      | 38         |          | S     |
| V <sub>SD</sub>             | Diode Forward Voltage                 | I <sub>S</sub> =-1A, V <sub>GS</sub> =0V                                                    |      | -0.72      | -1       | V     |
| I <sub>S</sub>              | Maximum Body-Diode Continuous Current |                                                                                             |      |            | -4.2     | A     |
| <b>DYNAMIC PARAMETERS</b>   |                                       |                                                                                             |      |            |          |       |
| C <sub>iss</sub>            | Input Capacitance                     | V <sub>GS</sub> =0V, V <sub>DS</sub> =-15V, f=1MHz                                          |      | 5034       |          | pF    |
| C <sub>oss</sub>            | Output Capacitance                    |                                                                                             |      | 1076       |          | pF    |
| C <sub>rss</sub>            | Reverse Transfer Capacitance          |                                                                                             |      | 829        |          | pF    |
| R <sub>g</sub>              | Gate resistance                       | V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, f=1MHz                                            |      | 2.5        |          | Ω     |
| <b>SWITCHING PARAMETERS</b> |                                       |                                                                                             |      |            |          |       |
| Q <sub>g</sub>              | Total Gate Charge                     | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-15V, I <sub>D</sub> =-15A                          |      | 78         |          | nC    |
| Q <sub>gs</sub>             | Gate Source Charge                    |                                                                                             |      | 15.2       |          | nC    |
| Q <sub>gd</sub>             | Gate Drain Charge                     |                                                                                             |      | 23.6       |          | nC    |
| t <sub>D(on)</sub>          | Turn-On DelayTime                     | V <sub>GS</sub> =-10V, V <sub>DS</sub> =-15V, R <sub>L</sub> =1.0Ω,<br>R <sub>GEN</sub> =3Ω |      | 17.5       |          | ns    |
| t <sub>r</sub>              | Turn-On Rise Time                     |                                                                                             |      | 19.5       |          | ns    |
| t <sub>D(off)</sub>         | Turn-Off DelayTime                    |                                                                                             |      | 49         |          | ns    |
| t <sub>f</sub>              | Turn-Off Fall Time                    |                                                                                             |      | 30.5       |          | ns    |
| t <sub>rr</sub>             | Body Diode Reverse Recovery Time      | I <sub>F</sub> =-15A, dI/dt=100A/μs                                                         |      | 43         |          | ns    |
| Q <sub>rr</sub>             | Body Diode Reverse Recovery Charge    | I <sub>F</sub> =-15A, dI/dt=100A/μs                                                         |      | 38         |          | nC    |

A: The value of R<sub>θJA</sub> is measured with the device mounted on 1in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=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<sub>s</sub> ≤ 10s thermal resistance rating.

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

C. The R<sub>θJA</sub> is the sum of the thermal impedance from junction to lead R<sub>θJL</sub> 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<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with T<sub>A</sub>=25°C. The SOA curve provides a single pulse rating.

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

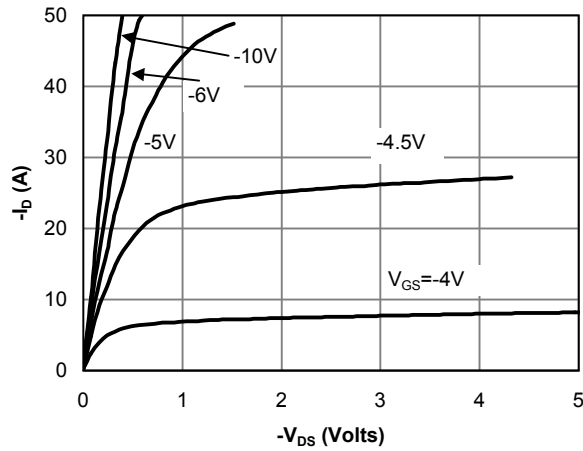


Fig 1: On-Region Characteristics

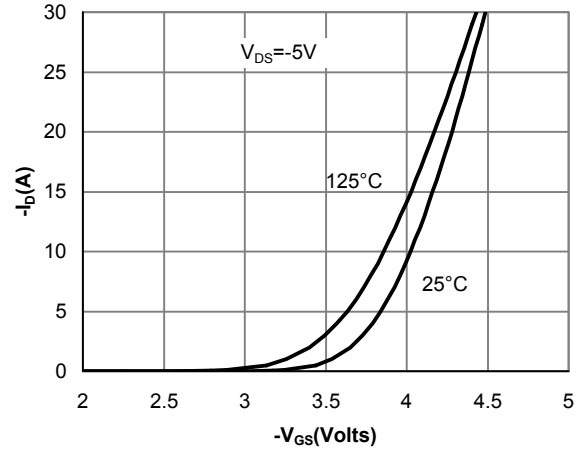


Figure 2: Transfer Characteristics

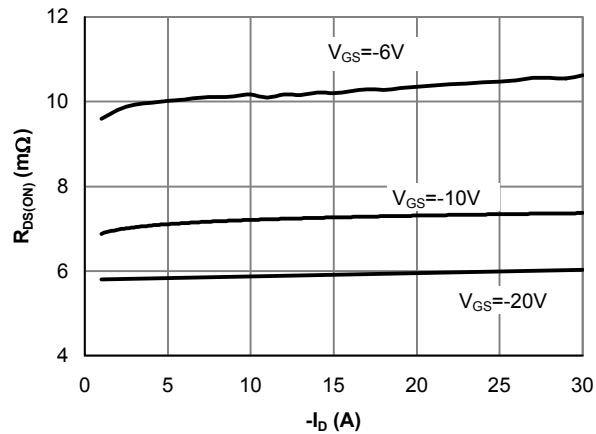


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

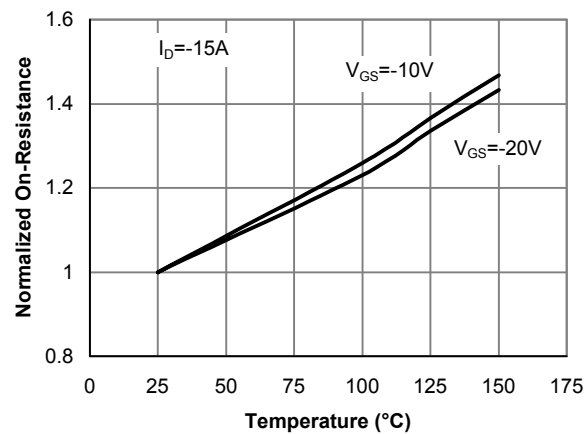


Figure 4: On-Resistance vs. Junction Temperature

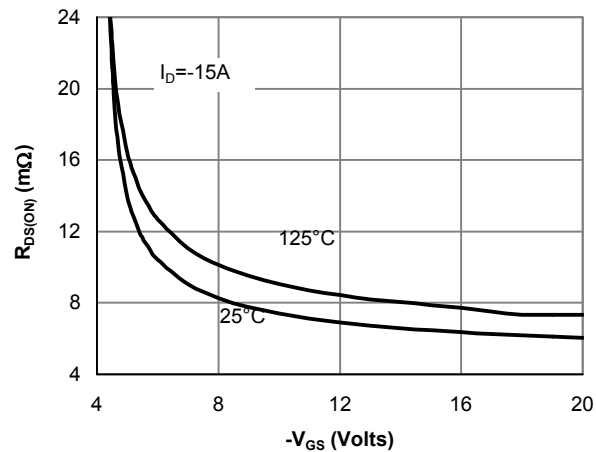


Figure 5: On-Resistance vs. Gate-Source Voltage

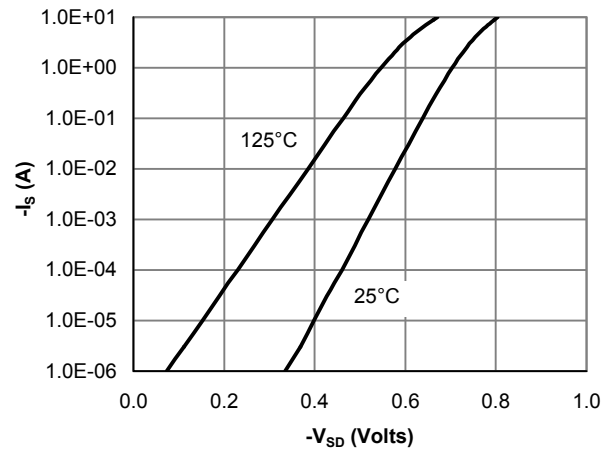


Figure 6: Body-Diode Characteristics

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

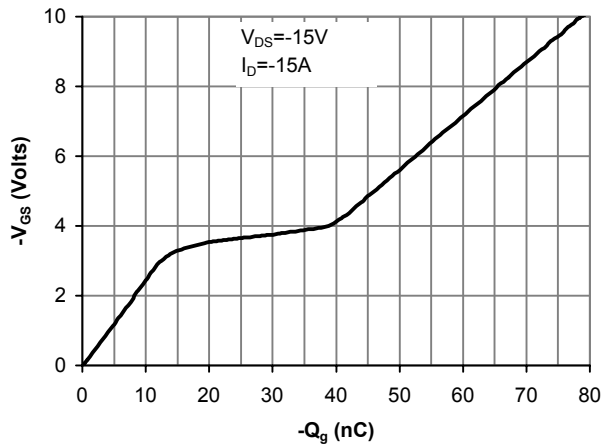


Figure 7: Gate-Charge Characteristics

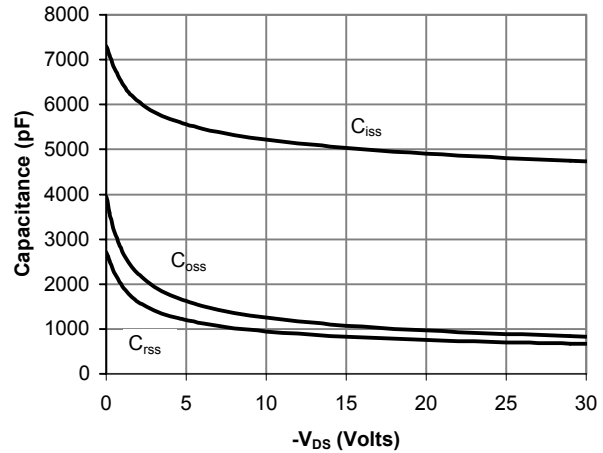


Figure 8: Capacitance Characteristics

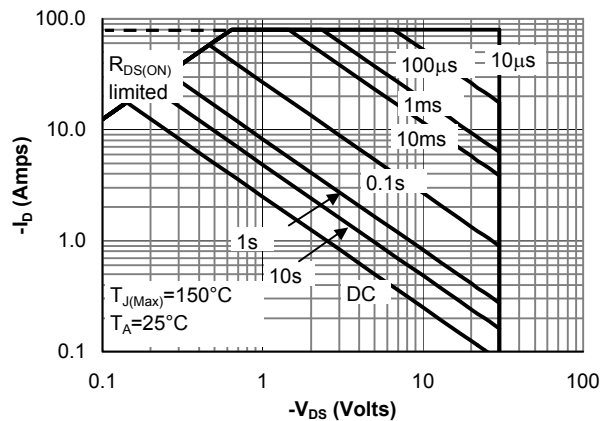


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

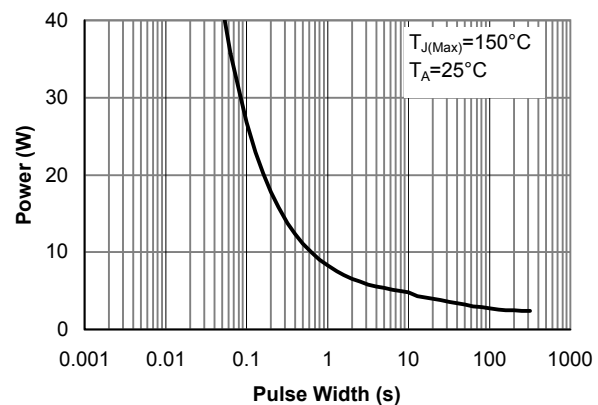


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

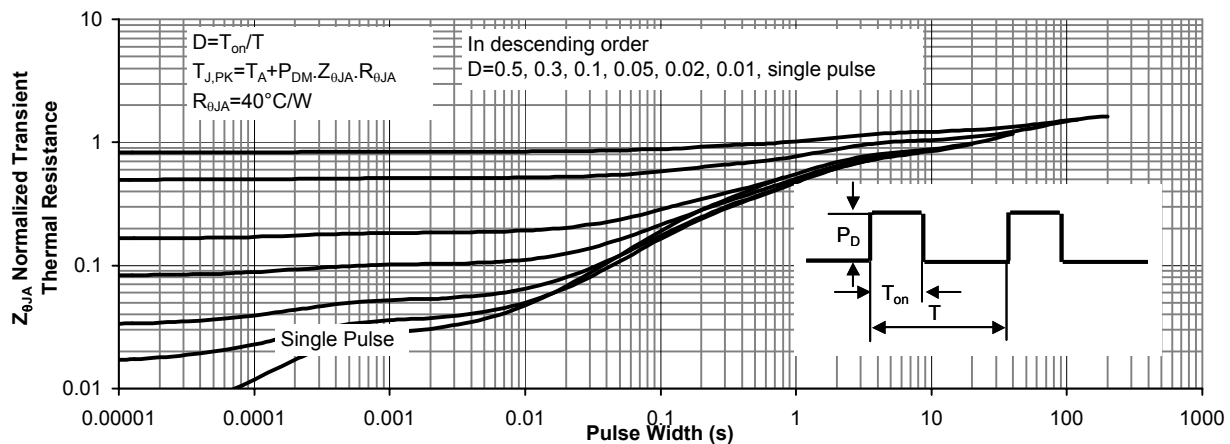
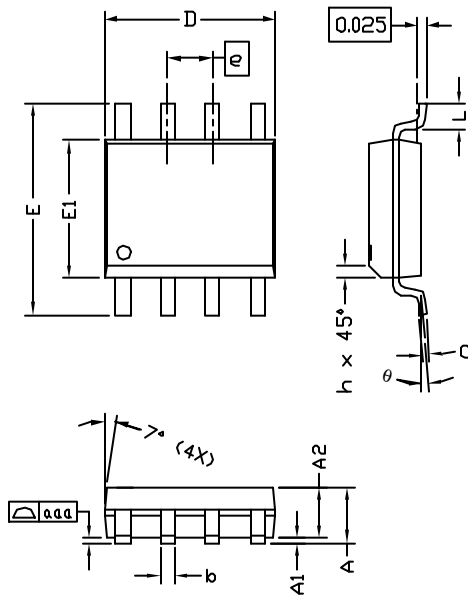


Figure 11: Normalized Maximum Transient Thermal Impedance



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## SOP-8 Package Data



| SYMBOLS | DIMENSIONS IN MILLIMETERS |      |      | DIMENSIONS IN INCHES |       |       |
|---------|---------------------------|------|------|----------------------|-------|-------|
|         | MIN                       | NOM  | MAX  | MIN                  | NOM   | MAX   |
| A       | 1.45                      | 1.50 | 1.55 | 0.057                | 0.059 | 0.061 |
| A1      | 0.00                      | —    | 0.10 | 0.000                | —     | 0.004 |
| A2      | —                         | 1.45 | —    | —                    | 0.057 | —     |
| b       | 0.33                      | —    | 0.51 | 0.013                | —     | 0.020 |
| c       | 0.19                      | —    | 0.25 | 0.007                | —     | 0.010 |
| D       | 4.80                      | —    | 5.00 | 0.189                | —     | 0.197 |
| E1      | 3.80                      | —    | 4.00 | 0.150                | —     | 0.157 |
| e       | 1.27 BSC                  |      |      | 0.050 BSC            |       |       |
| E       | 5.80                      | —    | 6.20 | 0.228                | —     | 0.244 |
| h       | 0.25                      | —    | 0.50 | 0.010                | —     | 0.020 |
| L       | 0.40                      | —    | 1.27 | 0.016                | —     | 0.050 |
| aaa     | —                         | —    | 0.10 | —                    | —     | 0.004 |
| θ       | 0°                        | —    | 8°   | 0°                   | —     | 8°    |

- NOTE:
1. LEAD FINISH: 150 MICROINCHES ( 3.8 um) MIN.  
THICKNESS OF Tin/Lead (SOLDER) PLATED ON LEAD
  2. TOLERANCE ±0.10 mm (4 mil) UNLESS OTHERWISE SPECIFIED
  3. COPLANARITY : 0.10 mm
  4. DIMENSION L IS MEASURED IN GAGE PLANE

### PACKAGE MARKING DESCRIPTION

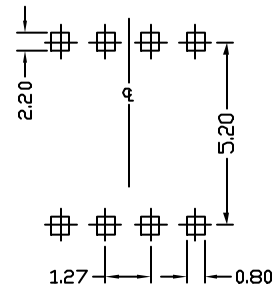


- NOTE:
- LOGO - AOS LOGO
  - 4413 - PART NUMBER CODE.
  - F - FAB LOCATION
  - A - ASSEMBLY LOCATION
  - Y - YEAR CODE
  - W - WEEK CODE.
  - L C - ASSEMBLY LOT CODE

### SOP-8 PART NO. CODE

| PART NO. | CODE |
|----------|------|
| AO4413   | 4413 |
|          |      |

### RECOMMENDED LAND PATTERN



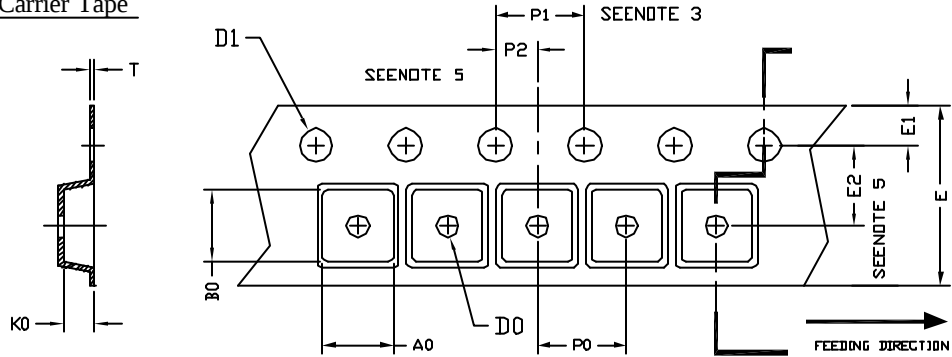
UNIT: mm



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## SO-8 Tape and Reel Data

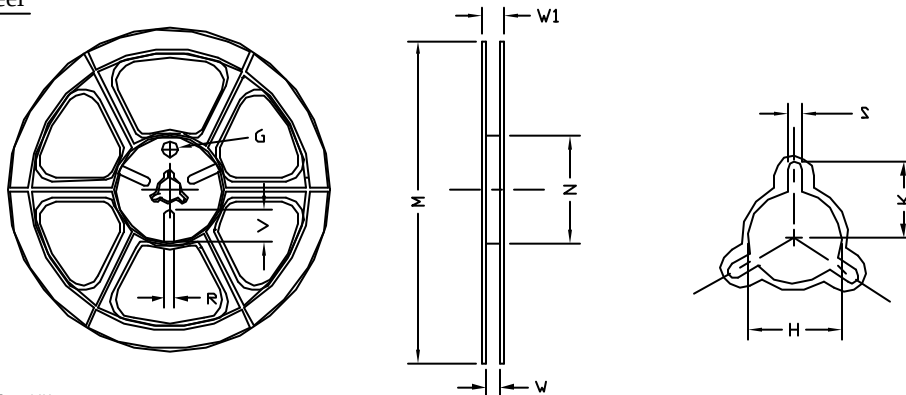
### SO-8 Carrier Tape



UNIT: MM

| PACKAGE         | A0            | B0            | K0            | D0            | D1            | E              | E1            | E2            | P0            | P1            | P2            | T             |
|-----------------|---------------|---------------|---------------|---------------|---------------|----------------|---------------|---------------|---------------|---------------|---------------|---------------|
| SO-8<br>(12 mm) | 6.40<br>±0.10 | 3.20<br>±0.10 | 2.10<br>±0.10 | 1.60<br>±0.10 | 1.30<br>±0.10 | 12.00<br>±0.30 | 1.75<br>±0.10 | 5.50<br>±0.05 | 8.00<br>±0.10 | 4.00<br>±0.10 | 2.00<br>±0.05 | 0.25<br>±0.05 |

### SO-8 Reel



UNIT: MM

| TAPE SIZE | REEL SIZE | M                | N               | W              | W1             | H                        | K     | S             | G   | R   | V   |
|-----------|-----------|------------------|-----------------|----------------|----------------|--------------------------|-------|---------------|-----|-----|-----|
| 12 mm     | Ø330      | Ø330.00<br>±0.50 | Ø97.00<br>±0.10 | 13.00<br>±0.30 | 17.40<br>±1.00 | Ø13.00<br>+0.50<br>-0.20 | 10.60 | 2.00<br>±0.50 | --- | --- | --- |

### SO-8 Tape

Leader / Trailer  
& Orientation

