



## AO4409

### P-Channel Enhancement Mode Field Effect Transistor

#### General Description

The AO4409 uses advanced trench technology to provide excellent  $R_{DS(ON)}$ , and ultra-low low gate charge. This device is suitable for use as a load switch or in PWM applications.

#### Features

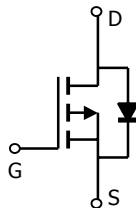
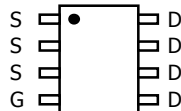
$V_{DS}$  (V) = -30V

$I_D$  = -15 A

Max  $R_{DS(ON)} < 7.5m\Omega$  ( $V_{GS} = -10V$ )

Max  $R_{DS(ON)} < 12m\Omega$  ( $V_{GS} = -4.5V$ )

**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                    | $V_{GS}$       | $\pm 20$   | V                |
| Continuous Drain Current <sup>A</sup>  | $I_D$          | -15        | A                |
|                                        |                | -12.8      |                  |
| Pulsed Drain Current <sup>B</sup>      | $I_{DM}$       | -80        |                  |
| Power Dissipation <sup>A</sup>         | $P_D$          | 3          | W                |
|                                        |                | 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> | $R_{\theta JA}$ | 26  | 40  | $^\circ\text{C/W}$ |
| Maximum Junction-to-Ambient <sup>A</sup> |                 | 50  | 75  | $^\circ\text{C/W}$ |
| Maximum Junction-to-Lead <sup>C</sup>    | $R_{\theta JL}$ | 14  | 24  | $^\circ\text{C/W}$ |

Electrical Characteristics ( $T_J=25^{\circ}\text{C}$  unless otherwise noted)

| Symbol                      | Parameter                             | Conditions                                                                         | Min  | Typ        | Max         | Units            |
|-----------------------------|---------------------------------------|------------------------------------------------------------------------------------|------|------------|-------------|------------------|
| <b>STATIC PARAMETERS</b>    |                                       |                                                                                    |      |            |             |                  |
| $BV_{DSS}$                  | Drain-Source Breakdown Voltage        | $I_D=-250\mu\text{A}$ , $V_{GS}=0\text{V}$                                         | -30  |            |             | V                |
| $I_{DSS}$                   | Zero Gate Voltage Drain Current       | $V_{DS}=-24\text{V}$ , $V_{GS}=0\text{V}$<br>$T_J=55^{\circ}\text{C}$              |      |            | -5<br>-25   | $\mu\text{A}$    |
| $I_{GSS}$                   | Gate-Body leakage current             | $V_{DS}=0\text{V}$ , $V_{GS}=\pm 20\text{V}$                                       |      |            | $\pm 100$   | nA               |
| $V_{GS(th)}$                | Gate Threshold Voltage                | $V_{DS}=V_{GS}$ , $I_D=-250\mu\text{A}$                                            | -1.4 | -1.9       | -2.7        | V                |
| $I_{D(ON)}$                 | On state drain current                | $V_{GS}=-10\text{V}$ , $V_{DS}=-5\text{V}$                                         | 80   |            |             | A                |
| $R_{DS(ON)}$                | Static Drain-Source On-Resistance     | $V_{GS}=-10\text{V}$ , $I_D=-15\text{A}$<br>$T_J=125^{\circ}\text{C}$              |      | 6.2<br>8.2 | 7.5<br>11.5 | $\text{m}\Omega$ |
|                             |                                       | $V_{GS}=-4.5\text{V}$ , $I_D=-10\text{A}$                                          |      | 9.5        | 12          | $\text{m}\Omega$ |
| $g_{FS}$                    | Forward Transconductance              | $V_{DS}=-5\text{V}$ , $I_D=-15\text{A}$                                            | 35   | 50         |             | S                |
| $V_{SD}$                    | Diode Forward Voltage                 | $I_S=-1\text{A}$ , $V_{GS}=0\text{V}$                                              |      | -0.71      | -1          | V                |
| $I_S$                       | Maximum Body-Diode Continuous Current |                                                                                    |      |            | -5          | A                |
| <b>DYNAMIC PARAMETERS</b>   |                                       |                                                                                    |      |            |             |                  |
| $C_{iss}$                   | Input Capacitance                     | $V_{GS}=0\text{V}$ , $V_{DS}=-15\text{V}$ , $f=1\text{MHz}$                        |      | 5270       |             | pF               |
| $C_{oss}$                   | Output Capacitance                    |                                                                                    |      | 945        |             | pF               |
| $C_{rss}$                   | Reverse Transfer Capacitance          |                                                                                    |      | 745        |             | pF               |
| $R_g$                       | Gate resistance                       | $V_{GS}=0\text{V}$ , $V_{DS}=0\text{V}$ , $f=1\text{MHz}$                          |      | 2          |             | $\Omega$         |
| <b>SWITCHING PARAMETERS</b> |                                       |                                                                                    |      |            |             |                  |
| $Q_g$                       | Total Gate Charge                     | $V_{GS}=-10\text{V}$ , $V_{DS}=-15\text{V}$ , $I_D=-15\text{A}$                    |      | 100        |             | nC               |
| $Q_{g(4.5V)}$               | Gate Charge                           |                                                                                    |      | 51.5       |             | nC               |
| $Q_{gs}$                    | Gate Source Charge                    |                                                                                    |      | 14.5       |             | nC               |
| $Q_{gd}$                    | Gate Drain Charge                     |                                                                                    |      | 23         |             | nC               |
| $t_{D(on)}$                 | Turn-On DelayTime                     | $V_{GS}=-10\text{V}$ , $V_{DS}=-15\text{V}$ , $R_L=1\Omega$ ,<br>$R_{GEN}=3\Omega$ |      | 14         |             | ns               |
| $t_r$                       | Turn-On Rise Time                     |                                                                                    |      | 16.5       |             | ns               |
| $t_{D(off)}$                | Turn-Off DelayTime                    |                                                                                    |      | 76.5       |             | ns               |
| $t_f$                       | Turn-Off Fall Time                    |                                                                                    |      | 37.5       |             | ns               |
| $t_{rr}$                    | Body Diode Reverse Recovery Time      | $I_F=-15\text{A}$ , $di/dt=100\text{A}/\mu\text{s}$                                |      | 36.7       |             | ns               |
| $Q_{rr}$                    | Body Diode Reverse Recovery Charge    | $I_F=-15\text{A}$ , $di/dt=100\text{A}/\mu\text{s}$                                |      | 28         |             | nC               |

A: The value of  $R_{\theta JA}$  is measured with the device mounted on 1in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with  $T_A=25^{\circ}\text{C}$ . The value in any a given application depends on the user's specific board design. The current rating is based on the  $t \leq 10\text{s}$  thermal resistance rating.

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

C: The  $R_{\theta JA}$  is the sum of the thermal impedance 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 80 $\mu\text{s}$  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  $T_A=25^{\circ}\text{C}$ . The SOA curve provides a single pulse rating.

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

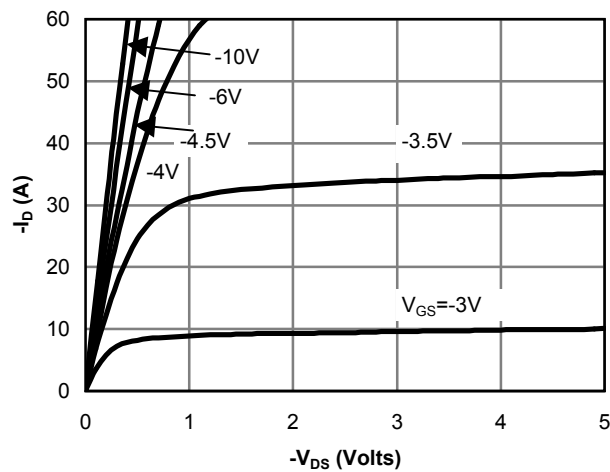


Fig 1: On-Region Characteristics

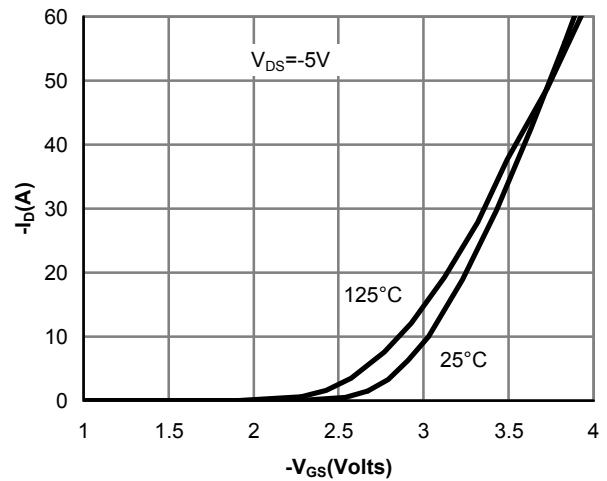


Figure 2: Transfer Characteristics

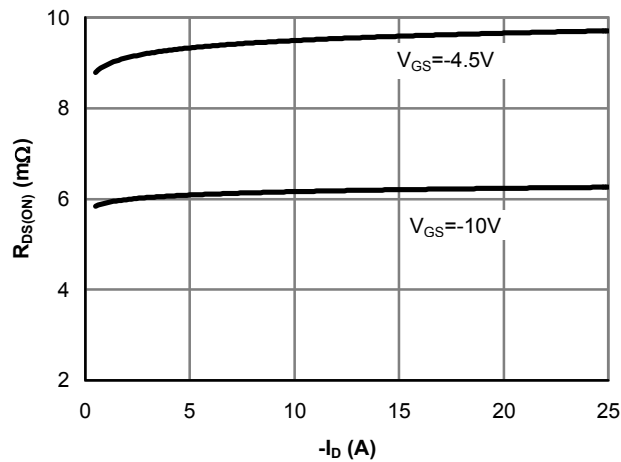


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

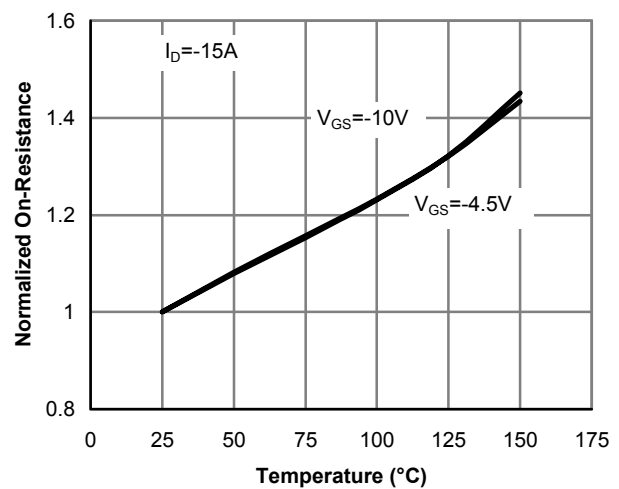


Figure 4: On-Resistance vs. Junction Temperature

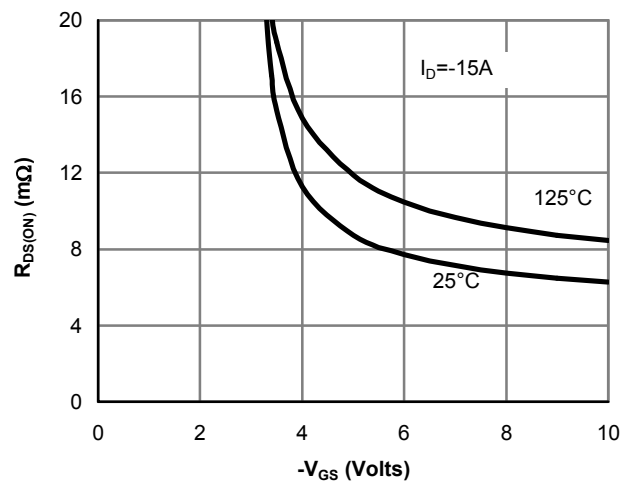


Figure 5: On-Resistance vs. Gate-Source Voltage

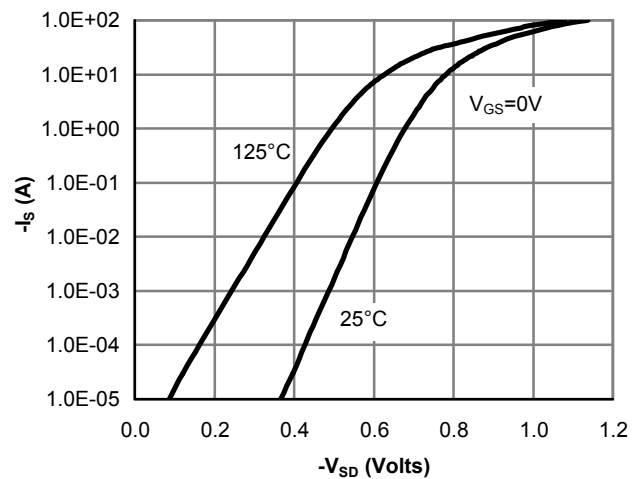


Figure 6: Body-Diode Characteristics

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

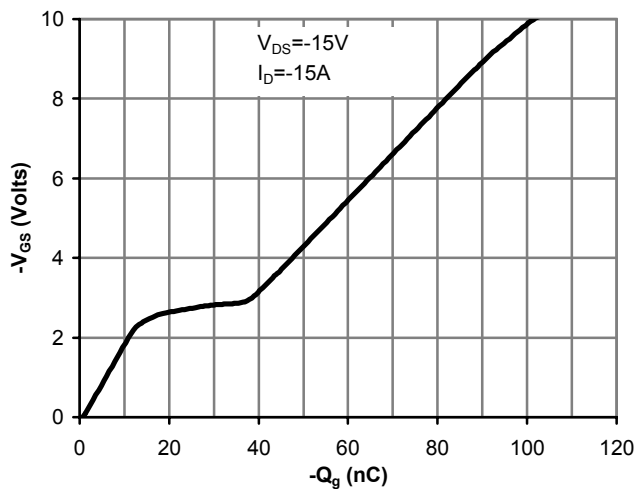


Figure 7: Gate-Charge Characteristics

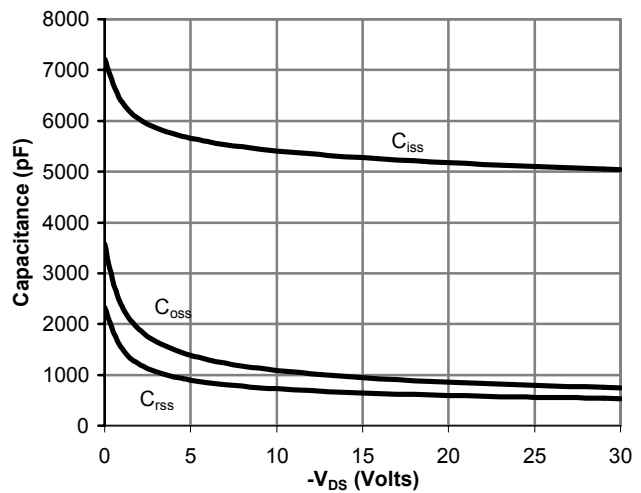


Figure 8: Capacitance Characteristics

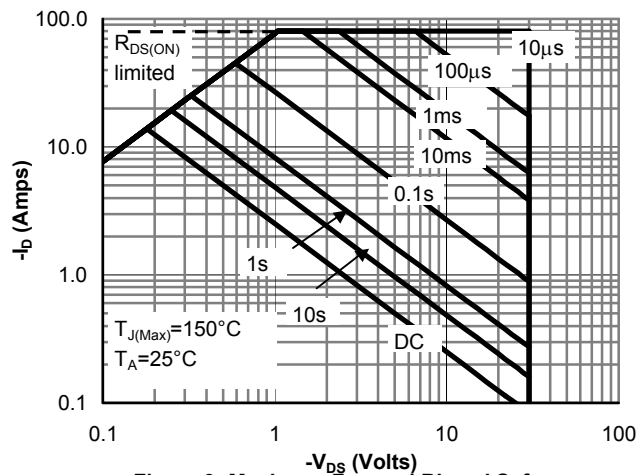


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

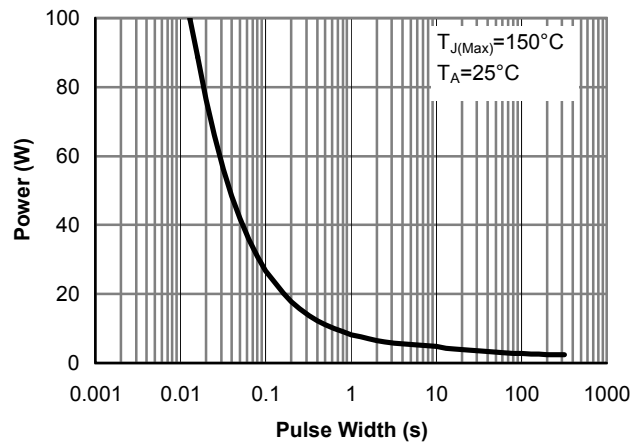


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

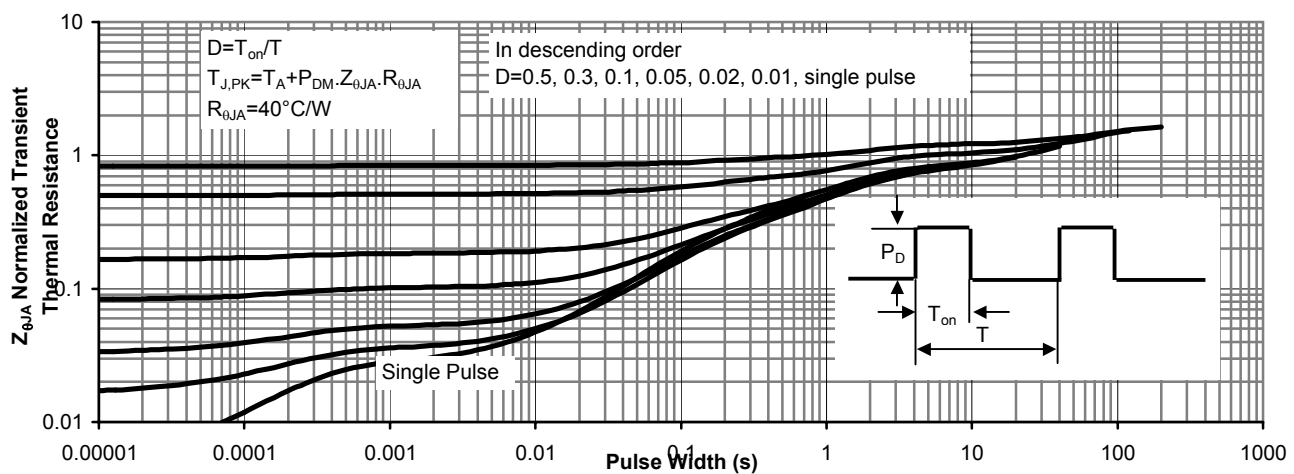
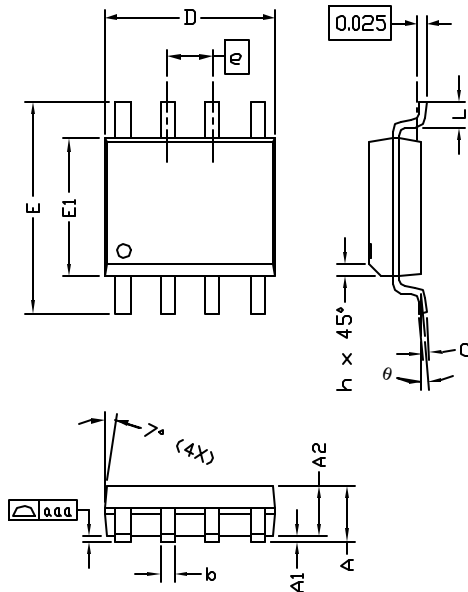


Figure 11: Normalized Maximum Transient Thermal Impedance



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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



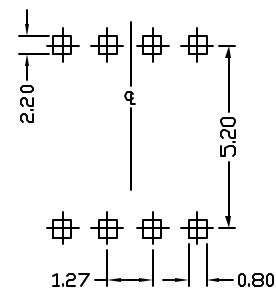
NOTE:

LOGO - AOS LOGO  
4409 - 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 |
|----------|------|
| AO4409   | 4409 |
|          |      |

### RECOMMENDED LAND PATTERN



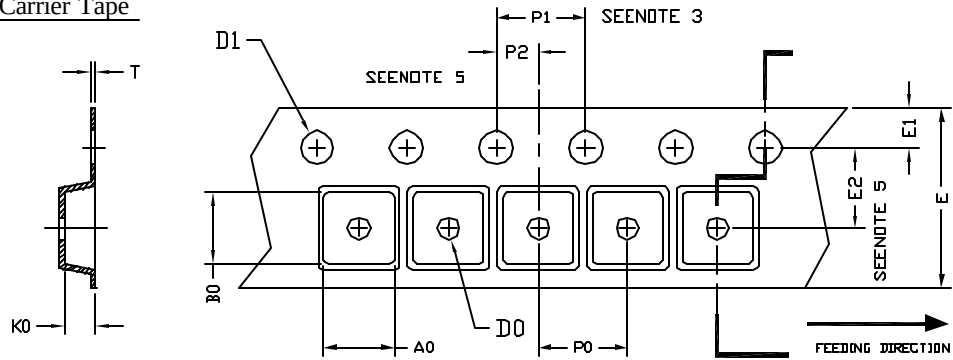
UNIT: mm



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## SO-8 Tape and Reel Data

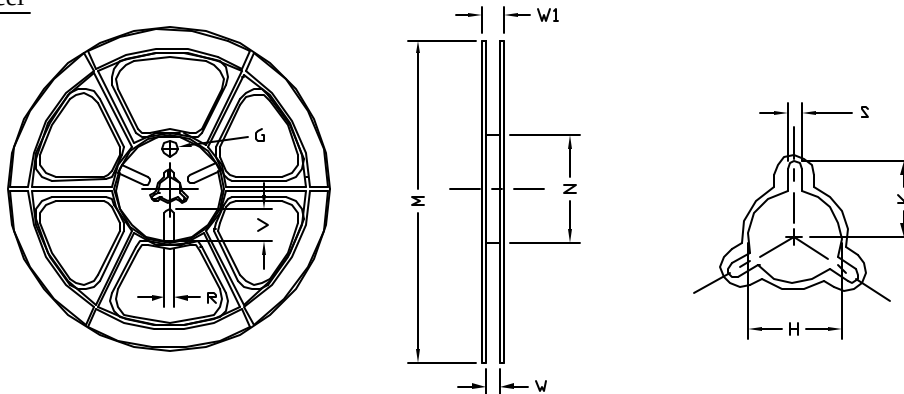
### SO-8 Carrier Tape



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 | 5.20<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     | φ330      | φ330.00<br>±0.50 | φ97.00<br>±0.10 | 13.00<br>±0.30 | 17.40<br>±1.00 | φ13.00<br>+0.50<br>-0.20 | 10.60 | 2.00<br>±0.50 | --- | --- | --- |

### SO-8 Tape

Leader / Trailer  
& Orientation

