



AO4609

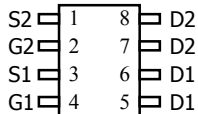
Complementary Enhancement Mode Field Effect Transistor

General Description

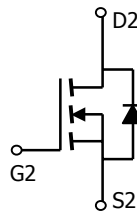
The AO4609 uses advanced trench technology MOSFETs to provide excellent $R_{DS(ON)}$ and low gate charge. The complementary MOSFETs may be used to form a level shifted high side switch, and for a host of other applications.

Features

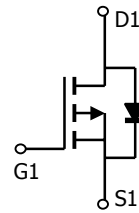
| | |
|----------------------------------|-------------------------------------|
| n-channel | p-channel |
| $V_{DS} (V) = 30V$ | -30V |
| $I_D = 8.5A$ | -3A |
| $R_{DS(ON)}$ | $R_{DS(ON)}$ |
| < 18m Ω ($V_{GS}=10V$) | < 130m Ω ($V_{GS} = 10V$) |
| < 28m Ω ($V_{GS}=4.5V$) | < 180m Ω ($V_{GS} = 4.5V$) |
| | < 260m Ω ($V_{GS} = 2.5V$) |



SOIC-8



n-channel



p-channel

Absolute Maximum Ratings $T_A=25^\circ C$ unless otherwise noted

| Parameter | Symbol | Max n-channel | Max p-channel | Units |
|--|------------------|---------------|---------------|------------|
| Drain-Source Voltage | V_{DS} | 30 | -30 | V |
| Gate-Source Voltage | V_{GS} | ± 20 | ± 12 | V |
| Continuous Drain Current ^A | $T_A=25^\circ C$ | 8.5 | -3 | A |
| | $T_A=70^\circ C$ | 6.6 | -2.4 | |
| Pulsed Drain Current ^B | I_{DM} | 40 | -6 | |
| Power Dissipation | $T_A=25^\circ C$ | 2 | 2 | W |
| | $T_A=70^\circ C$ | 1.28 | 1.28 | |
| Junction and Storage Temperature Range | T_J, T_{STG} | -55 to 150 | -55 to 150 | $^\circ C$ |

Thermal Characteristics: n-channel and p-channel

| Parameter | Symbol | Device | Typ | Max | Units |
|--|-----------------|--------|-----|------|--------------|
| Maximum Junction-to-Ambient ^A | $R_{\theta JA}$ | n-ch | 48 | 62.5 | $^\circ C/W$ |
| Maximum Junction-to-Ambient ^A | | n-ch | 74 | 110 | $^\circ C/W$ |
| Maximum Junction-to-Lead ^C | $R_{\theta JL}$ | n-ch | 35 | 40 | $^\circ C/W$ |
| Maximum Junction-to-Ambient ^A | $R_{\theta JA}$ | p-ch | 56 | 62.5 | $^\circ C/W$ |
| Maximum Junction-to-Ambient ^A | | p-ch | 81 | 110 | $^\circ C/W$ |
| Maximum Junction-to-Lead ^C | $R_{\theta JL}$ | p-ch | 40 | 48 | $^\circ C/W$ |

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

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-----------------------------|---------------------------------------|--|-----|--------------|----------|------------------|
| STATIC PARAMETERS | | | | | | |
| 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 | $V_{DS}=24\text{V}$, $V_{GS}=0\text{V}$ $T_J=55^\circ\text{C}$ | | | 1 5 | μA |
| I_{GSS} | Gate-Body leakage current | $V_{DS}=0\text{V}$, $V_{GS}=\pm 20\text{V}$ | | | 100 | nA |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}=V_{GS}$, $I_D=250\mu\text{A}$ | 1 | 1.8 | 3 | V |
| $I_{D(ON)}$ | On state drain current | $V_{GS}=10\text{V}$, $V_{DS}=5\text{V}$ | 30 | | | A |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}=10\text{V}$, $I_D=8.5\text{A}$ $T_J=125^\circ\text{C}$ | | 15.5 22.3 | 18 27 | $\text{m}\Omega$ |
| | | $V_{GS}=4.5\text{V}$, $I_D=6\text{A}$ | | 23 | 28 | $\text{m}\Omega$ |
| g_{FS} | Forward Transconductance | $V_{DS}=5\text{V}$, $I_D=8.5\text{A}$ | | 23 | | S |
| V_{SD} | Diode Forward Voltage | $I_S=1\text{A}$, $V_{GS}=0\text{V}$ | | 0.75 | 1 | V |
| I_S | Maximum Body-Diode Continuous Current | | | | 3 | A |
| DYNAMIC PARAMETERS | | | | | | |
| C_{iss} | Input Capacitance | $V_{GS}=0\text{V}$, $V_{DS}=15\text{V}$, $f=1\text{MHz}$ | | 1040 | | pF |
| C_{oss} | Output Capacitance | | | 180 | | pF |
| C_{rss} | Reverse Transfer Capacitance | | | 110 | | pF |
| R_g | Gate resistance | $V_{GS}=0\text{V}$, $V_{DS}=0\text{V}$, $f=1\text{MHz}$ | | 0.7 | | Ω |
| SWITCHING PARAMETERS | | | | | | |
| $Q_g(10\text{V})$ | Total Gate Charge | $V_{GS}=10\text{V}$, $V_{DS}=15\text{V}$, $I_D=8.5\text{A}$ | | 19.2 | | nC |
| $Q_g(4.5\text{V})$ | Total Gate Charge | | | 9.36 | | nC |
| Q_{gs} | Gate Source Charge | | | 2.6 | | nC |
| Q_{gd} | Gate Drain Charge | | | 4.2 | | nC |
| $t_{D(on)}$ | Turn-On DelayTime | $V_{GS}=10\text{V}$, $V_{DS}=15\text{V}$, $R_L=1.8\Omega$, $R_{GEN}=3\Omega$ | | 5.2 | | ns |
| t_r | Turn-On Rise Time | | | 4.4 | | ns |
| $t_{D(off)}$ | Turn-Off DelayTime | | | 17.3 | | ns |
| t_f | Turn-Off Fall Time | | | 3.3 | | ns |
| t_{rr} | Body Diode Reverse Recovery Time | $I_F=8.5\text{A}$, $dI/dt=100\text{A}/\mu\text{s}$ | | 16.7 | | ns |
| Q_{rr} | Body Diode Reverse Recovery Charge | $I_F=8.5\text{A}$, $dI/dt=100\text{A}/\mu\text{s}$ | | 6.7 | | nC |

A: The value of $R_{\theta JA}$ is measured with the device mounted on 1 in² 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 are obtained using 80 μs pulses, duty cycle 0.5% max.

E. These tests are performed with the device mounted on 1 in² 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.

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

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-----------------------------|---------------------------------------|--|------|-------|-----------|---------------|
| STATIC PARAMETERS | | | | | | |
| 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 | $V_{DS}=-24\text{V}$, $V_{GS}=0\text{V}$ $T_J=55^\circ\text{C}$ | | | -1 -5 | μA |
| I_{GSS} | Gate-Body leakage current | $V_{DS}=0\text{V}$, $V_{GS}=\pm 12\text{V}$ | | | ± 100 | nA |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}=V_{GS}$, $I_D=-250\mu\text{A}$ | -0.6 | -1 | -1.4 | V |
| $I_{D(ON)}$ | On state drain current | $V_{GS}=-4.5\text{V}$, $V_{DS}=-5\text{V}$ | -10 | | | A |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}=-10\text{V}$, $I_D=-3\text{A}$ $T_J=125^\circ\text{C}$ | | 102 | 130 | m Ω |
| | | $V_{GS}=-4.5\text{V}$, $I_D=-2\text{A}$ | | 154 | 200 | |
| | | $V_{GS}=-2.5\text{V}$, $I_D=-1\text{A}$ | | 128 | 180 | m Ω |
| g_{FS} | Forward Transconductance | $V_{DS}=-5\text{V}$, $I_D=-3\text{A}$ | 3 | 4.5 | | S |
| V_{SD} | Diode Forward Voltage | $I_S=-1\text{A}$, $V_{GS}=0\text{V}$ | | -0.85 | -1 | V |
| I_S | Maximum Body-Diode Continuous Current | | | | -2 | A |
| DYNAMIC PARAMETERS | | | | | | |
| C_{iss} | Input Capacitance | $V_{GS}=0\text{V}$, $V_{DS}=-15\text{V}$, $f=1\text{MHz}$ | | 409 | | pF |
| C_{oss} | Output Capacitance | | | 55 | | pF |
| C_{riss} | Reverse Transfer Capacitance | | | 42 | | pF |
| R_g | Gate resistance | $V_{GS}=0\text{V}$, $V_{DS}=0\text{V}$, $f=1\text{MHz}$ | | 12 | | Ω |
| SWITCHING PARAMETERS | | | | | | |
| Q_g | Total Gate Charge | $V_{GS}=-4.5\text{V}$, $V_{DS}=-15\text{V}$, $I_D=-3\text{A}$ | | 4.4 | | nC |
| Q_{gs} | Gate Source Charge | | | 0.8 | | nC |
| Q_{gd} | Gate Drain Charge | | | 1.32 | | nC |
| $t_{D(on)}$ | Turn-On DelayTime | $V_{GS}=-10\text{V}$, $V_{DS}=-15\text{V}$, $R_L=5\Omega$, $R_{GEN}=3\Omega$ | | 5.3 | | ns |
| t_r | Turn-On Rise Time | | | 4.4 | | ns |
| $t_{D(off)}$ | Turn-Off DelayTime | | | 31.5 | | ns |
| t_f | Turn-Off Fall Time | | | 8 | | ns |
| t_{rr} | Body Diode Reverse Recovery Time | $I_F=-3\text{A}$, $dI/dt=100\text{A}/\mu\text{s}$ | | 15.8 | | ns |
| Q_{rr} | Body Diode Reverse Recovery Charge | $I_F=-3\text{A}$, $dI/dt=100\text{A}/\mu\text{s}$ | | 8 | | 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 $T_A=25^\circ\text{C}$. 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 μs pulses, duty cycle 0.5% max.

E: These tests are performed with the device mounted on 1 in² 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.

N-CHANNEL: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

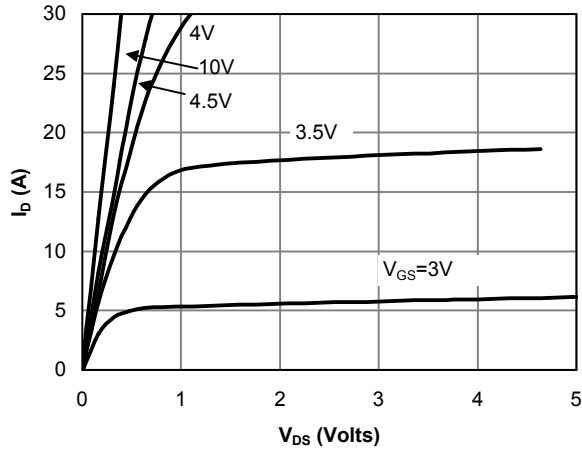


Fig 1: On-Region Characteristics

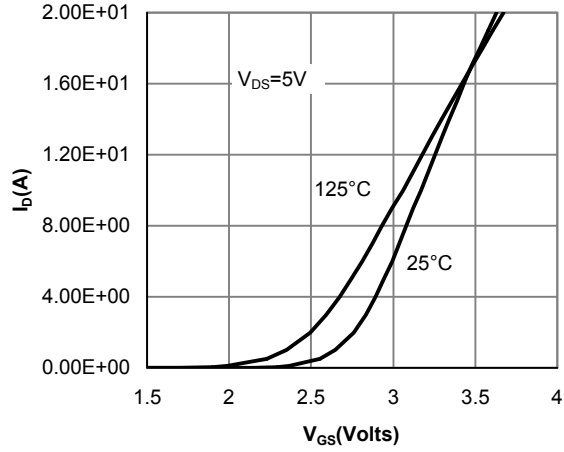


Figure 2: Transfer Characteristics

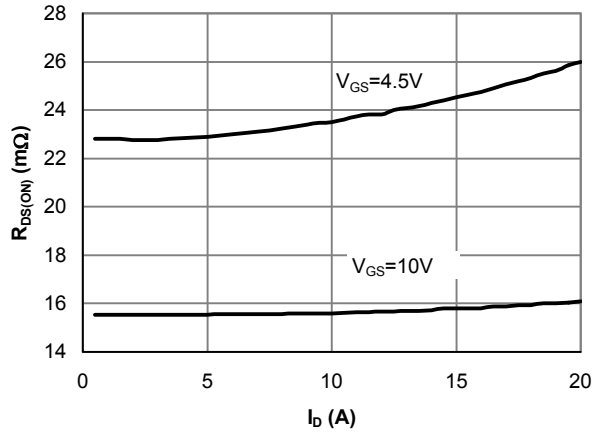


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

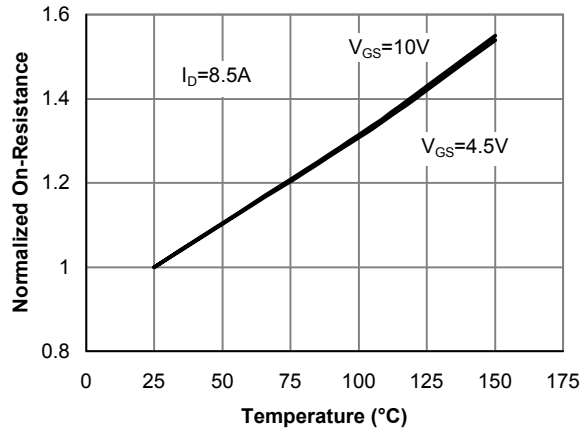


Figure 4: On-Resistance vs. Junction Temperature

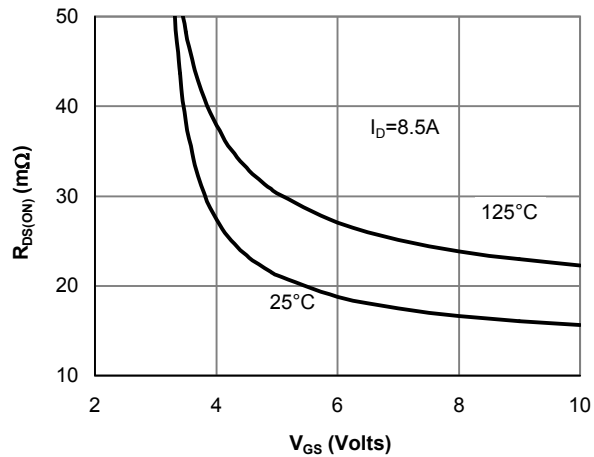


Figure 5: On-Resistance vs. Gate-Source Voltage

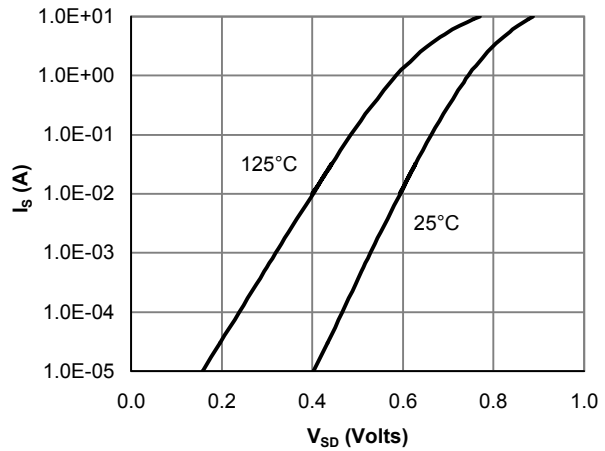


Figure 6: Body-Diode Characteristics

N-CHANNEL: TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

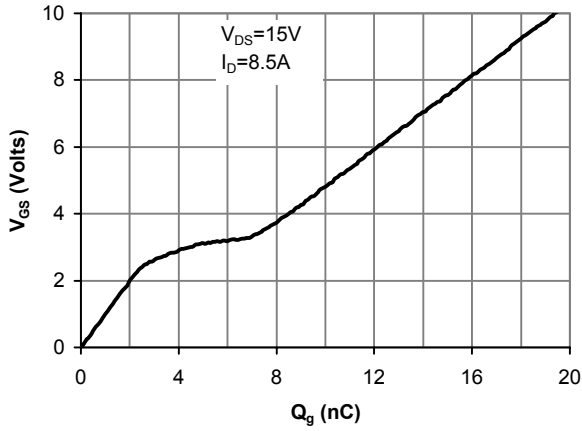


Figure 7: Gate-Charge Characteristics

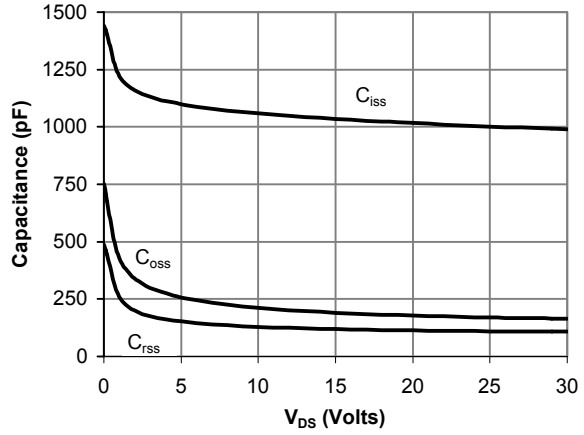


Figure 8: Capacitance Characteristics

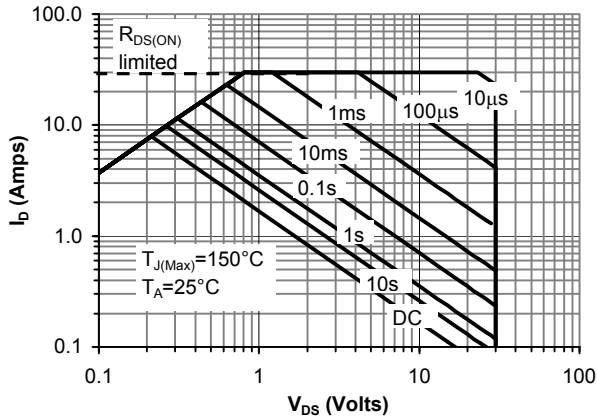


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

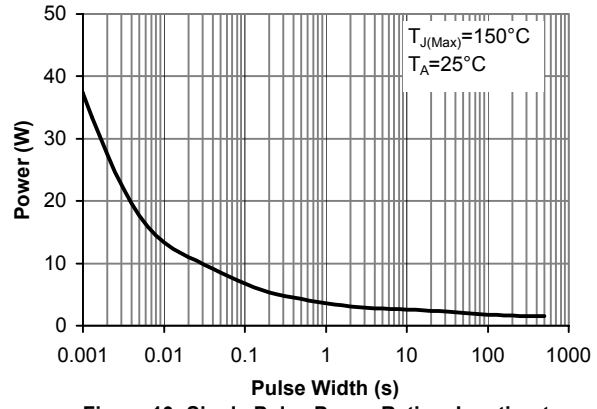


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

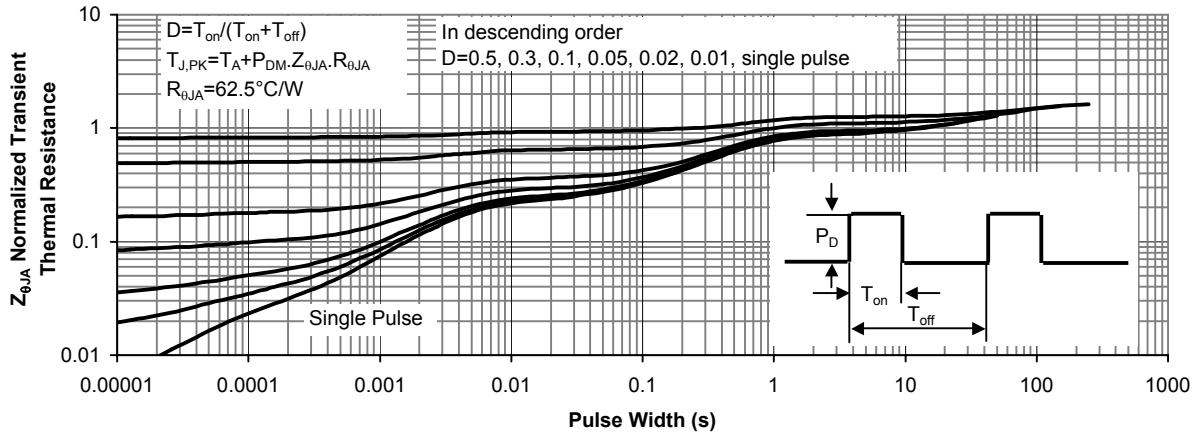


Figure 11: Normalized Maximum Transient Thermal Impedance

P-CHANNEL TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

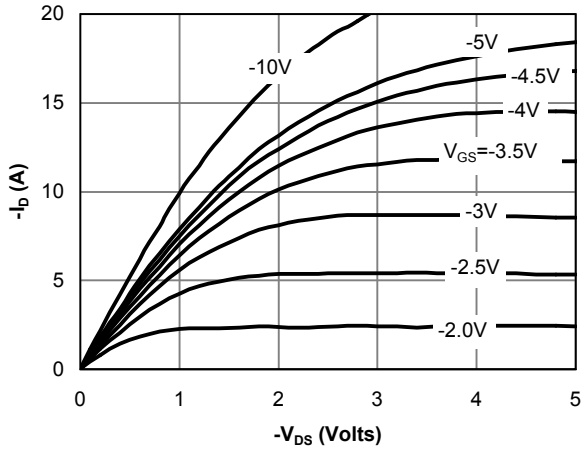


Fig 1: On-Region Characteristics

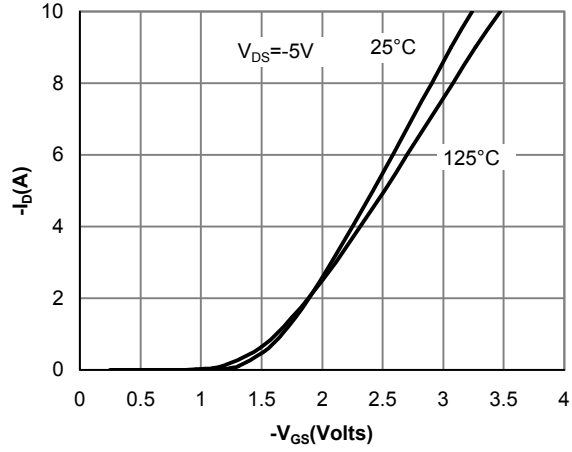


Figure 2: Transfer Characteristics

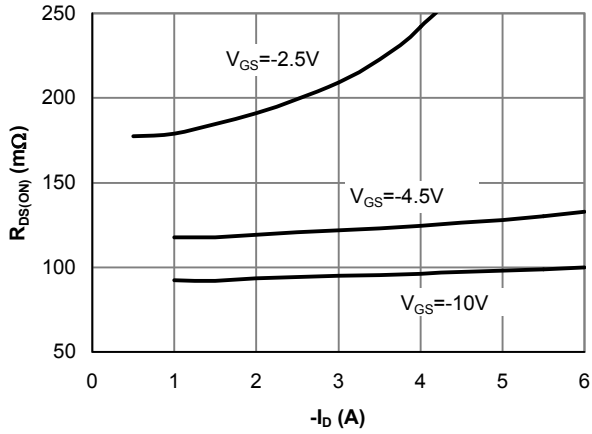


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

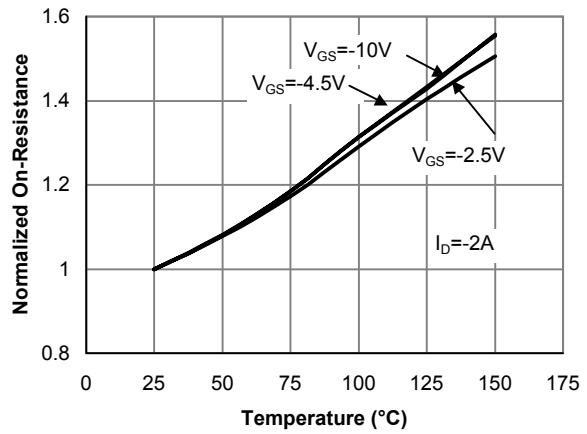


Figure 4: On-Resistance vs. Junction Temperature

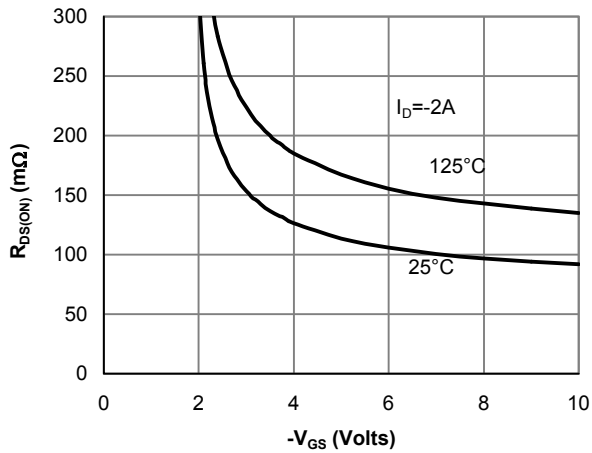


Figure 5: On-Resistance vs. Gate-Source Voltage

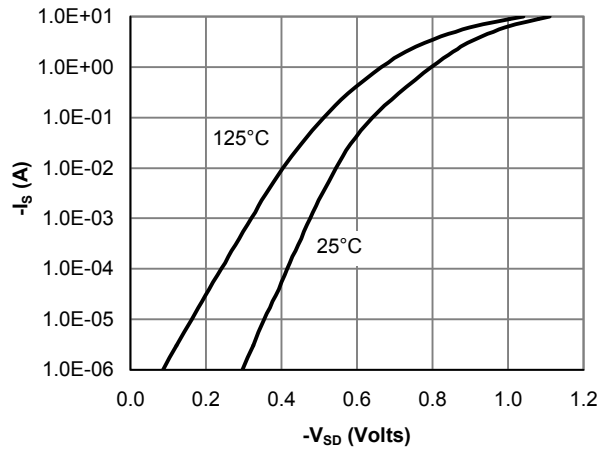


Figure 6: Body-Diode Characteristics

P-CHANNEL TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

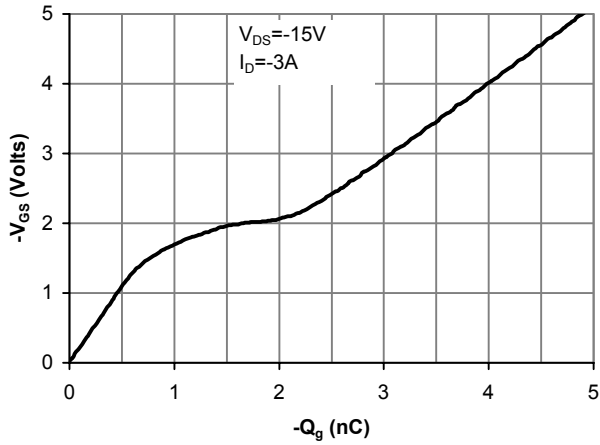


Figure 7: Gate-Charge Characteristics

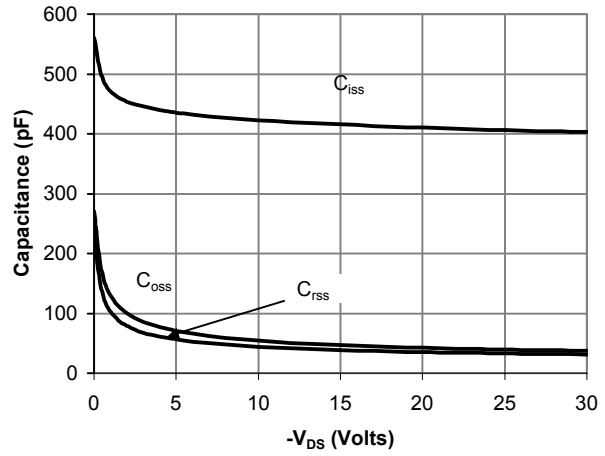


Figure 8: Capacitance Characteristics

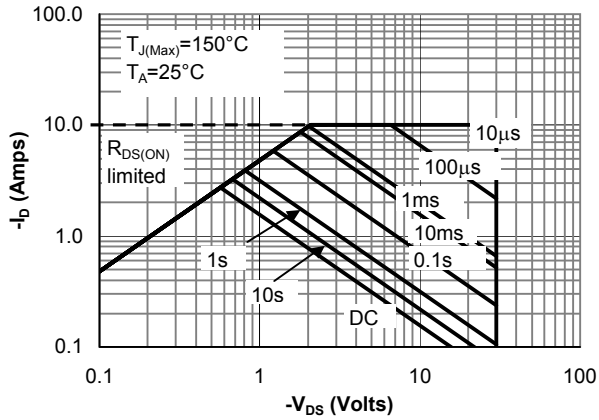


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

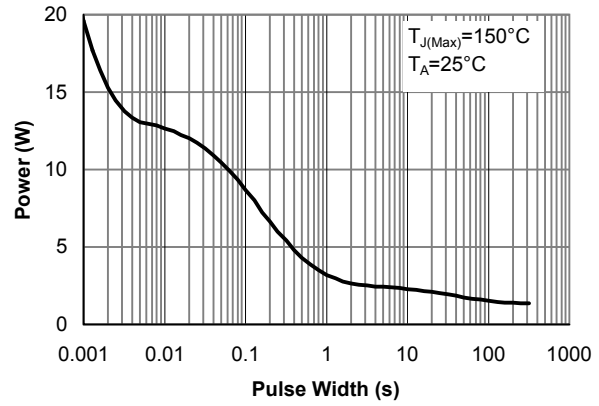


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

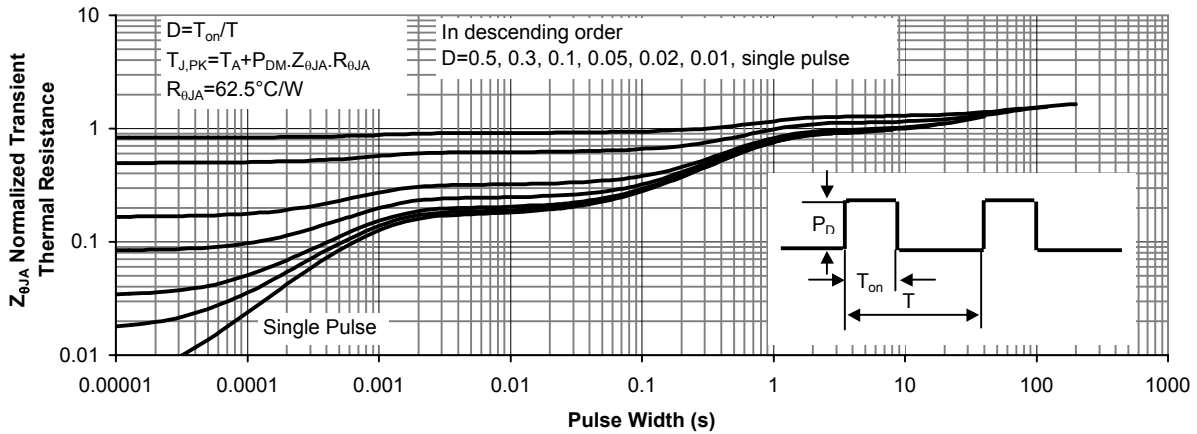
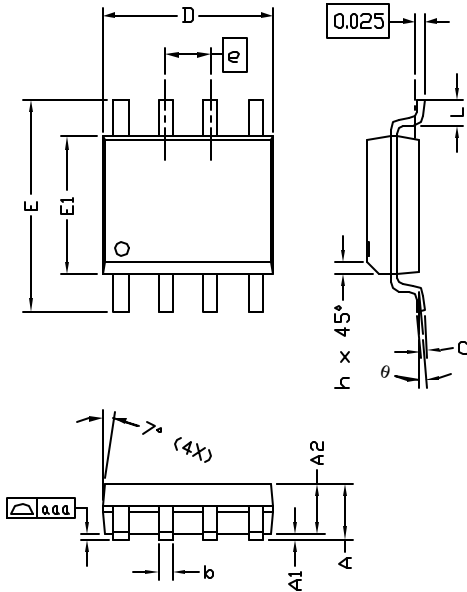


Figure 11: Normalized Maximum Transient Thermal Impedance



ALPHA & OMEGA
SEMICONDUCTOR, INC.

SO-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 MICRONS (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



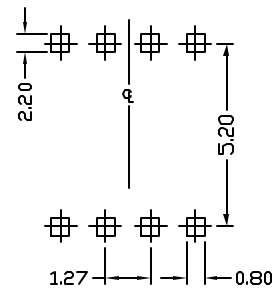
NOTE:

- LOGO - AOS LOGO
- 4609 - PART NUMBER CODE.
- F - FAB LOCATION
- A - ASSEMBLY LOCATION
- Y - YEAR CODE
- W - WEEK CODE.
- L C - ASSEMBLY LOT CODE

SO-8 PART NO. CODE

| PART NO. | CODE |
|----------|------|
| AO4609 | 4609 |

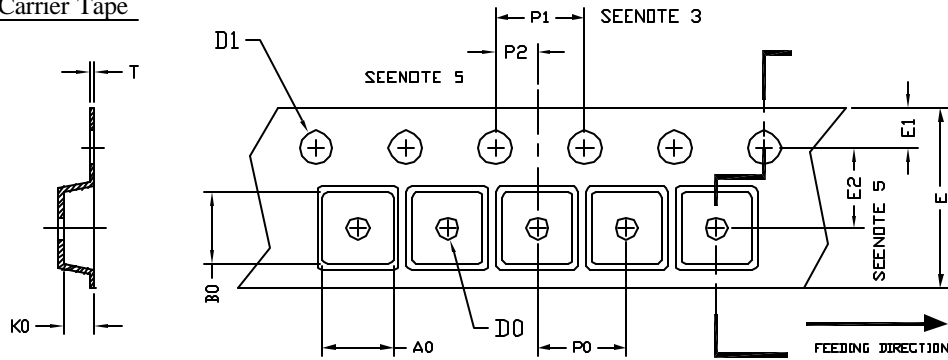
RECOMMENDED LAND PATTERN



UNIT: mm



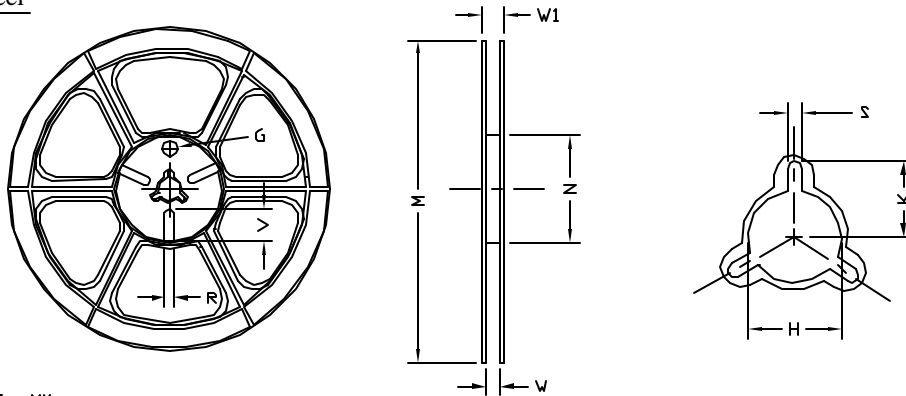
SO-8 Carrier Tape



UNIT: MM

| PACKAGE | A0 | B0 | K0 | D0 | D1 | E | E1 | E2 | P0 | P1 | P2 | T |
|-----------------|---------------|---------------|---------------|---------------|---------------|----------------|---------------|---------------|---------------|---------------|---------------|---------------|
| SO-8 (12 mm) | 6.40 ±0.10 | 5.20 ±0.10 | 2.10 ±0.10 | 1.60 ±0.10 | 1.30 +0.10 | 12.00 ±0.30 | 1.75 ±0.10 | 5.50 ±0.05 | 8.00 ±0.10 | 4.00 ±0.10 | 2.00 ±0.05 | 0.25 ±0.05 |

SO-8 Reel

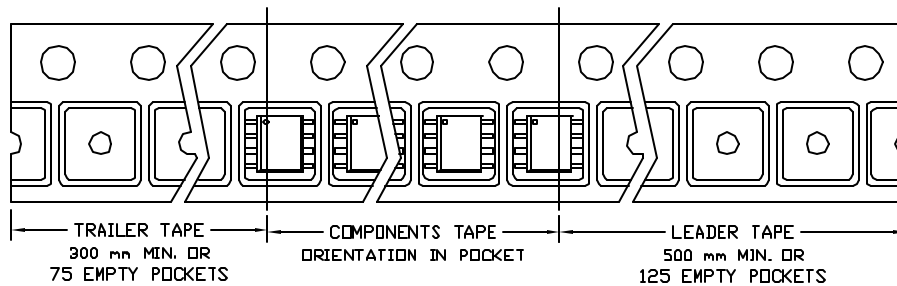


UNIT: MM

| TAPE SIZE | REEL SIZE | M | N | W | W1 | H | K | S | G | R | V |
|-----------|-----------|------------------|-----------------|----------------|----------------|--------------------------|-------|---------------|-----|-----|-----|
| 12 mm | φ330 | φ330.00 ±0.50 | φ97.00 ±0.10 | 13.00 ±0.30 | 17.40 ±1.00 | φ13.00 +0.50 -0.20 | 10.60 | 2.00 ±0.50 | --- | --- | --- |

SO-8 Tape

Leader / Trailer
& Orientation

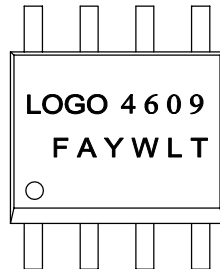




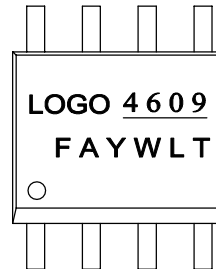
ALPHA & OMEGA
SEMICONDUCTOR, LTD.

| | |
|--------------|----------------------------|
| Document No. | PD-00064 |
| Version | rev C |
| Title | AO4609 Marking Description |

SO-8 PACKAGE MARKING DESCRIPTION



Standard product

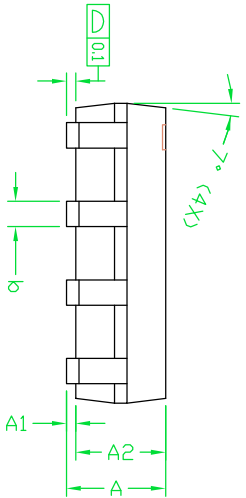
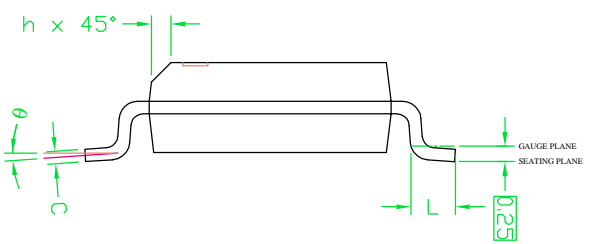
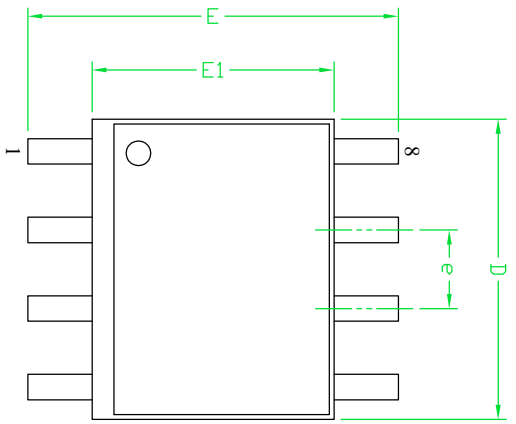


Green product

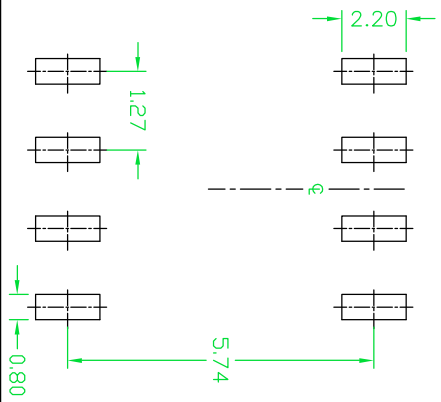
NOTE:

LOGO - AOS LOGO
4609 - PART NUMBER CODE.
F&A - FOUNDRY AND ASSEMBLY LOCATION
Y - YEAR CODE
W - WEEK CODE.
L T - ASSEMBLY LOT CODE

| PART NO. | DESCRIPTION | CODE |
|----------|------------------|-------------|
| AO4609 | Standard product | 4609 |
| AO4609L | Green product | <u>4609</u> |



RECOMMENDED LAND PATTERN



- NOTE**
1. ALL DIMENSIONS ARE IN MILLIMETERS.
 2. DIMENSIONS ARE INCLUSIVE OF PLATING.
 3. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS.
 4. DIMENSION L IS MEASURED IN GAUGE PLANE.
 5. CONTROLLING DIMENSION IS MILLIMETER, CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.

| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---------|---------------------------|------|------|----------------------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.35 | 1.65 | 1.75 | 0.053 | 0.065 | 0.069 |
| A1 | 0.10 | — | 0.25 | 0.004 | — | 0.010 |
| A2 | 1.25 | 1.50 | 1.65 | 0.049 | 0.059 | 0.065 |
| b | 0.31 | — | 0.51 | 0.012 | — | 0.020 |
| c | 0.17 | — | 0.25 | 0.007 | — | 0.010 |
| D | 4.80 | 4.90 | 5.00 | 0.189 | 0.193 | 0.197 |
| E1 | 3.80 | 3.90 | 4.00 | 0.150 | 0.154 | 0.157 |
| e | 1.27 BSC | | | 0.050 BSC | | |
| E | 5.80 | 6.00 | 6.20 | 0.228 | 0.236 | 0.244 |
| h | 0.25 | — | 0.50 | 0.010 | — | 0.020 |
| L | 0.40 | — | 1.27 | 0.016 | — | 0.050 |
| θ | 0° | — | 8° | 0° | — | 8° |

UNIT: mm

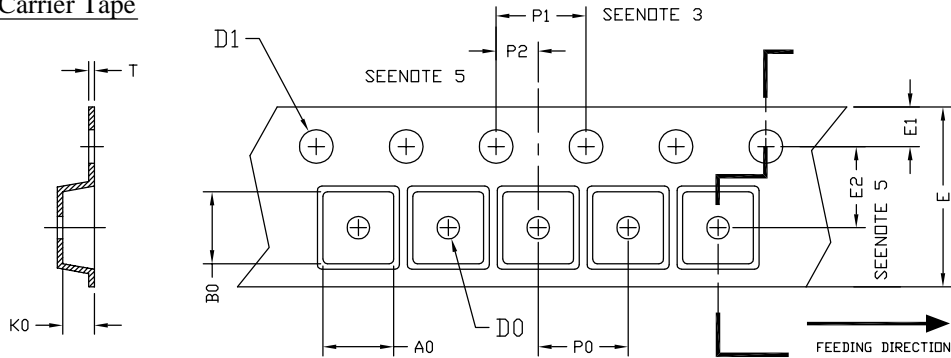
| | | | |
|--|-------------------------------|--------------|----------------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES DECIMAL XX ± XXX ± XXXX ± INTERPRET DIM AND TOL PER ASME Y14.5M - 1994 PRINTING IS SCALED TO FIT DO NOT SCALE DRAWING | THIRD ANGLE PROJECTION | Document No. | |
| | | Version | |
| | | Title | SO-8 PACKAGE OUTLINE |



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SO-8 Tape and Reel Data

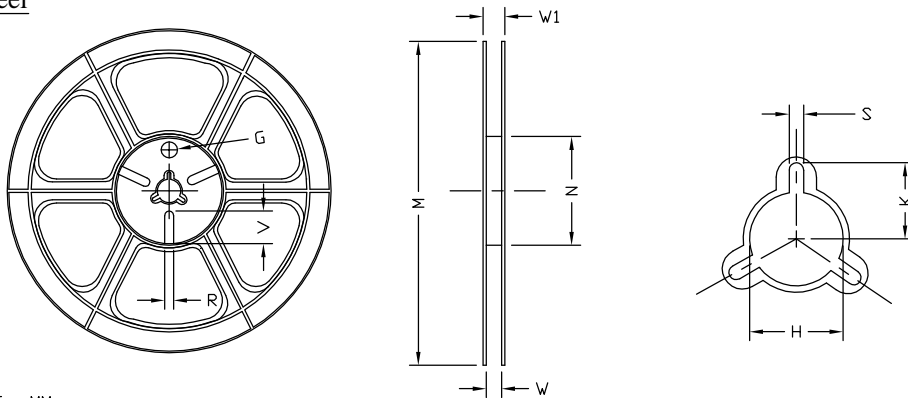
SO-8 Carrier Tape



UNIT: MM

| PACKAGE | A0 | B0 | K0 | D0 | D1 | E | E1 | E2 | P0 | P1 | P2 | T |
|-----------------|---------------|---------------|---------------|---------------|---------------|----------------|---------------|---------------|---------------|---------------|---------------|---------------|
| SD-8 (12 mm) | 6.40 ±0.10 | 5.20 ±0.10 | 2.10 ±0.10 | 1.60 ±0.10 | 1.50 +0.10 | 12.00 ±0.30 | 1.75 ±0.10 | 5.50 ±0.05 | 8.00 ±0.10 | 4.00 ±0.10 | 2.00 ±0.05 | 0.25 ±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 ±0.50 | ø97.00 ±0.10 | 13.00 ±0.30 | 17.40 ±1.00 | ø13.00 +0.50 -0.20 | 10.60 | 2.00 ±0.50 | --- | --- | --- |

SO-8 Tape

Leader / Trailer
& Orientation

