



ALPHA & OMEGA
SEMICONDUCTOR, INC.

Nov 2002

AO4604

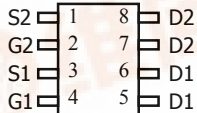
Complementary Enhancement Mode Field Effect Transistor

General Description

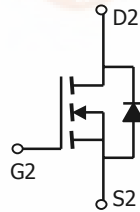
The AO4604 uses advanced trench technology MOSFETs to provide excellent $R_{DS(ON)}$ and low gate charge. The complementary MOSFETs may be used in power inverters, and other applications.

Features

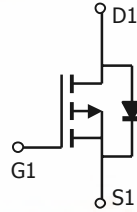
| | |
|-----------------------------|-------------------------------|
| n-channel | p-channel |
| $V_{DS} (V) = 30V$ | -30V |
| $I_D = 6.9A$ | -5A |
| $R_{DS(ON)}$ | $R_{DS(ON)}$ |
| $< 28m\Omega (V_{GS}=10V)$ | $< 52m\Omega (V_{GS} = 10V)$ |
| $< 42m\Omega (V_{GS}=4.5V)$ | $< 87m\Omega (V_{GS} = 4.5V)$ |



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 | ± 20 | V | |
| Continuous Drain Current ^A | I_D | $T_A=25^\circ C$ | 6.9 | -5 | A |
| | | $T_A=70^\circ C$ | 5.8 | -4.2 | |
| Pulsed Drain Current ^B | I_{DM} | 30 | -20 | | |
| Power Dissipation | P_D | $T_A=25^\circ C$ | 2 | 2 | W |
| | | $T_A=70^\circ C$ | 1.44 | 1.44 | |
| 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 | 48 | 62.5 | $^\circ C/W$ |
| Maximum Junction-to-Ambient ^A | | p-ch | 74 | 110 | $^\circ C/W$ |
| Maximum Junction-to-Lead ^C | $R_{\theta JL}$ | p-ch | 35 | 40 | $^\circ C/W$ |



Electrical Characteristics (T_J=25°C unless otherwise noted): N-CHANNEL

| 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 T _J =55°C | | | 1 5 | μA |
| I _{GSS} | Gate-Body leakage current | V _{DS} =0V, V _{GS} =±20V | | | 100 | nA |
| V _{GS(th)} | Gate Threshold Voltage | V _{DS} =V _{GS} I _D =250μA | 1 | 1.9 | 3 | V |
| I _{D(ON)} | On state drain current | V _{GS} =4.5V, V _{DS} =5V | 20 | | | A |
| R _{DS(ON)} | Static Drain-Source On-Resistance | V _{GS} =10V, I _D =6.9A T _J =125°C | | 22.5 31.3 | 28 38 | mΩ |
| | | V _{GS} =4.5V, I _D =5.0A | | 34.5 | 42 | |
| g _{FS} | Forward Transconductance | V _{DS} =5V, I _D =6.9A | 10 | 15.4 | | S |
| V _{SD} | Diode Forward Voltage | I _S =1A | | 0.76 | 1 | V |
| I _S | Maximum Body-Diode Continuous Current | | | | 3 | A |
| DYNAMIC PARAMETERS | | | | | | |
| C _{iss} | Input Capacitance | V _{GS} =0V, V _{DS} =15V, f=1MHz | | 680 | | pF |
| C _{oss} | Output Capacitance | | | 102 | | pF |
| C _{rss} | Reverse Transfer Capacitance | | | 77 | | pF |
| R _g | Gate resistance | V _{GS} =0V, V _{DS} =0V, f=1MHz | | 3 | | Ω |
| SWITCHING PARAMETERS | | | | | | |
| Q _g (10V) | Total Gate Charge | V _{GS} =10V, V _{DS} =15V, I _D =6.9A | | 13.84 | | nC |
| Q _g (4.5V) | Total Gate Charge | | | 6.74 | | nC |
| Q _{gs} | Gate Source Charge | | | 1.82 | | nC |
| Q _{gd} | Gate Drain Charge | | | 3.2 | | nC |
| t _{D(on)} | Turn-On DelayTime | V _{GS} =10V, V _{DS} =15V, R _L =2.2Ω, R _{GEN} =3Ω | | 4.6 | | ns |
| t _r | Turn-On Rise Time | | | 4.1 | | ns |
| t _{D(off)} | Turn-Off DelayTime | | | 20.6 | | ns |
| t _f | Turn-Off Fall Time | | | 5.2 | | ns |
| t _{rr} | Body Diode Reverse Recovery Time | I _F =6.9A, di/dt=100A/μs | | 16.5 | | ns |
| Q _{rr} | Body Diode Reverse Recovery Charge | I _F =6.9A, di/dt=100A/μs | | 7.8 | | nC |

A: The value of R_{θJA} 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 a given application depends on the user's specific board design. The current rating is based on the t_s ≤ 10s thermal resistance rating.

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

C. The R_{θJA} is the sum of the thermal impedance from junction to lead R_{θJL} and lead to ambient.

D. The static characteristics in Figures 1 to 6 are obtained using 80μs 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°C. The SOA curve provides a single pulse rating.

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

| 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 | $V_{DS}=-24\text{V}$, $V_{GS}=0\text{V}$ | | | -1 | μA |
| | | $T_J=55^\circ\text{C}$ | | | -5 | |
| 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 | $V_{GS}=-4.5\text{V}$, $V_{DS}=-5\text{V}$ | -10 | | | A |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}=-10\text{V}$, $I_D=5.0\text{A}$ | | 39 | 52 | $\text{m}\Omega$ |
| | | $T_J=125^\circ\text{C}$ | | 54 | 70 | |
| | | $V_{GS}=-4.5\text{V}$, $I_D=-4\text{A}$ | | 67 | 87 | $\text{m}\Omega$ |
| g_{FS} | Forward Transconductance | $V_{DS}=-5\text{V}$, $I_D=-5\text{A}$ | 6 | 8.6 | | S |
| V_{SD} | Diode Forward Voltage | $I_S=-1\text{A}$, $V_{GS}=0\text{V}$ | | -0.77 | -1 | V |
| I_S | Maximum Body-Diode Continuous Current | | | | -2.8 | A |
| DYNAMIC PARAMETERS | | | | | | |
| C_{iss} | Input Capacitance | $V_{GS}=0\text{V}$, $V_{DS}=-15\text{V}$, $f=1\text{MHz}$ | | 700 | | pF |
| C_{oss} | Output Capacitance | | | 120 | | pF |
| C_{rss} | Reverse Transfer Capacitance | | | 75 | | pF |
| R_g | Gate resistance | $V_{GS}=0\text{V}$, $V_{DS}=0\text{V}$, $f=1\text{MHz}$ | | 10 | | Ω |
| SWITCHING PARAMETERS | | | | | | |
| $Q_g(10\text{V})$ | Total Gate Charge (10V) | $V_{GS}=-10\text{V}$, $V_{DS}=-15\text{V}$, $I_D=-5\text{A}$ | | 14.7 | | nC |
| $Q_g(4.5\text{V})$ | Total Gate Charge (4.5V) | | | 7.6 | | nC |
| Q_{gs} | Gate Source Charge | | | 2 | | nC |
| Q_{gd} | Gate Drain Charge | | | 3.8 | | nC |
| $t_{D(on)}$ | Turn-On DelayTime | | | 8.3 | | ns |
| t_r | Turn-On Rise Time | $V_{GS}=-10\text{V}$, $V_{DS}=-15\text{V}$, $R_L=3\Omega$, $R_{GEN}=3\Omega$ | | 5 | | ns |
| $t_{D(off)}$ | Turn-Off DelayTime | | | 29 | | ns |
| t_f | Turn-Off Fall Time | | | 14 | | ns |
| t_{rr} | Body Diode Reverse Recovery Time | $I_F=-5\text{A}$, $dI/dt=100\text{A}/\mu\text{s}$ | | 23.5 | | ns |
| Q_{rr} | Body Diode Reverse Recovery Charge | $I_F=-5\text{A}$, $dI/dt=100\text{A}/\mu\text{s}$ | | 13.4 | | 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

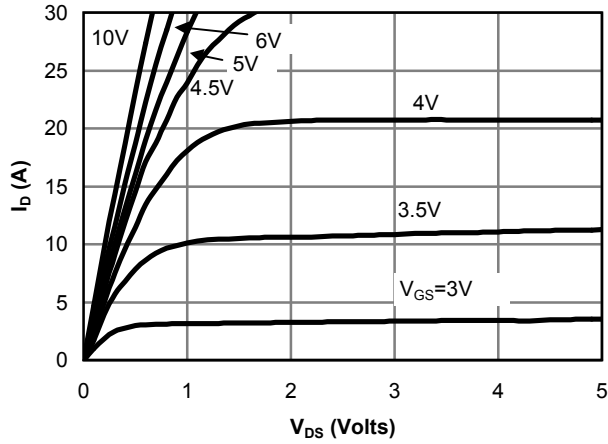


Fig 1: On-Region Characteristics

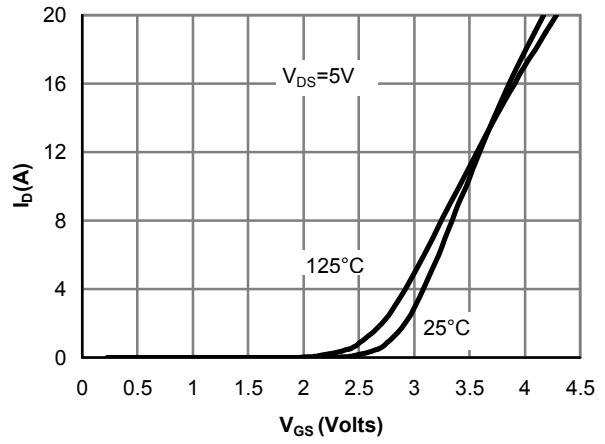


Figure 2: Transfer Characteristics

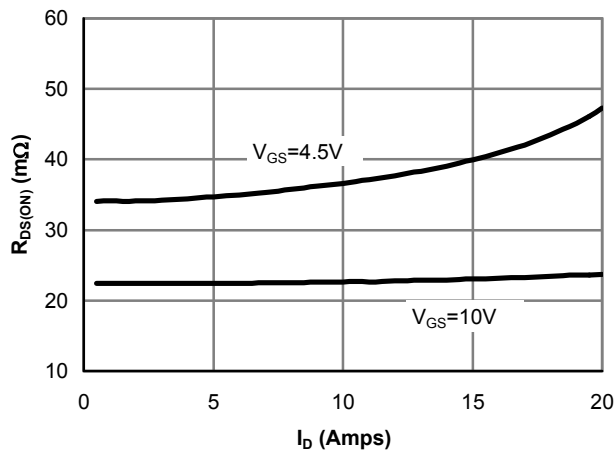


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

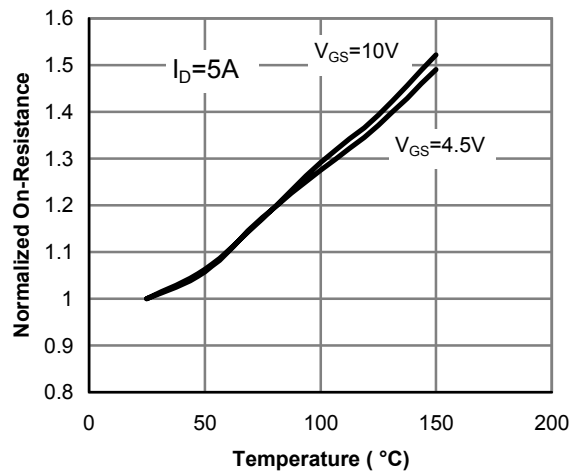


Figure 4: On-Resistance vs. Junction Temperature

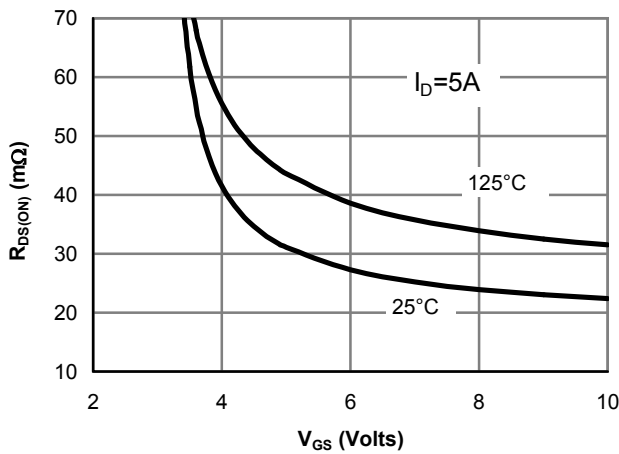


Figure 5: On-Resistance vs. Gate-Source Voltage

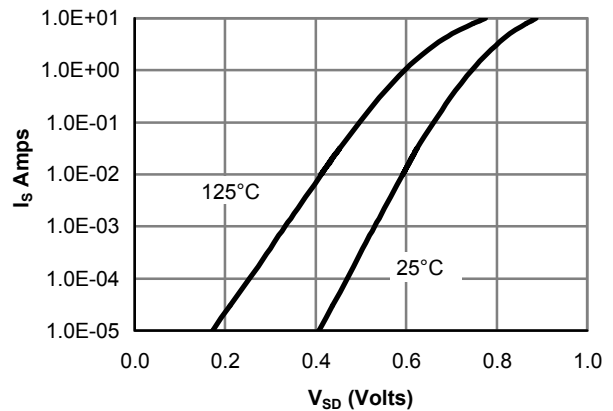


Figure 6: Body diode characteristics

N-CHANNEL TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

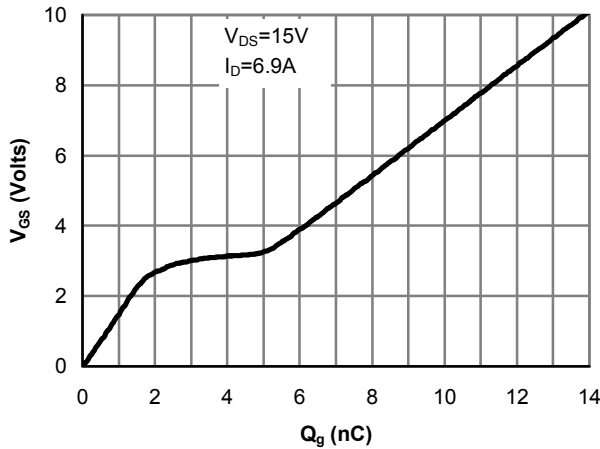


Figure 7: Gate-Charge characteristics

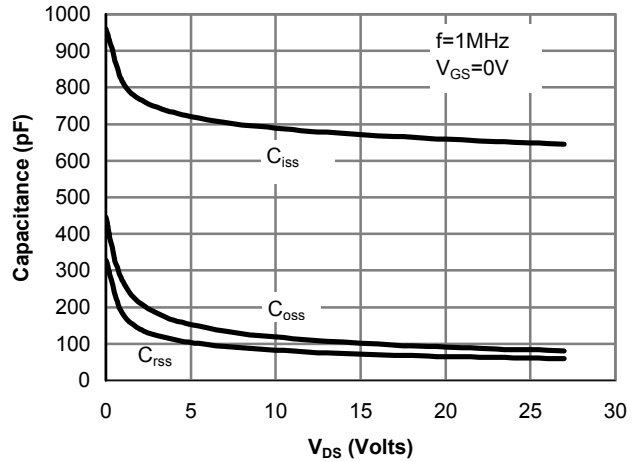


Figure 8: Capacitance Characteristics

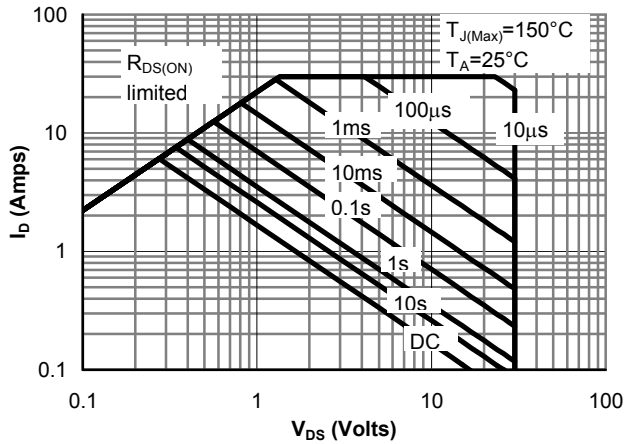


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

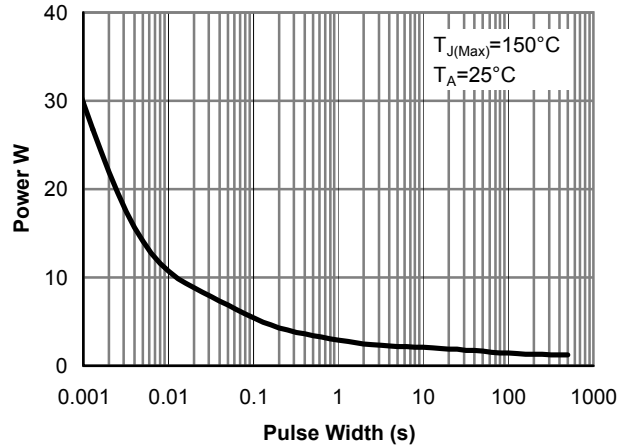


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

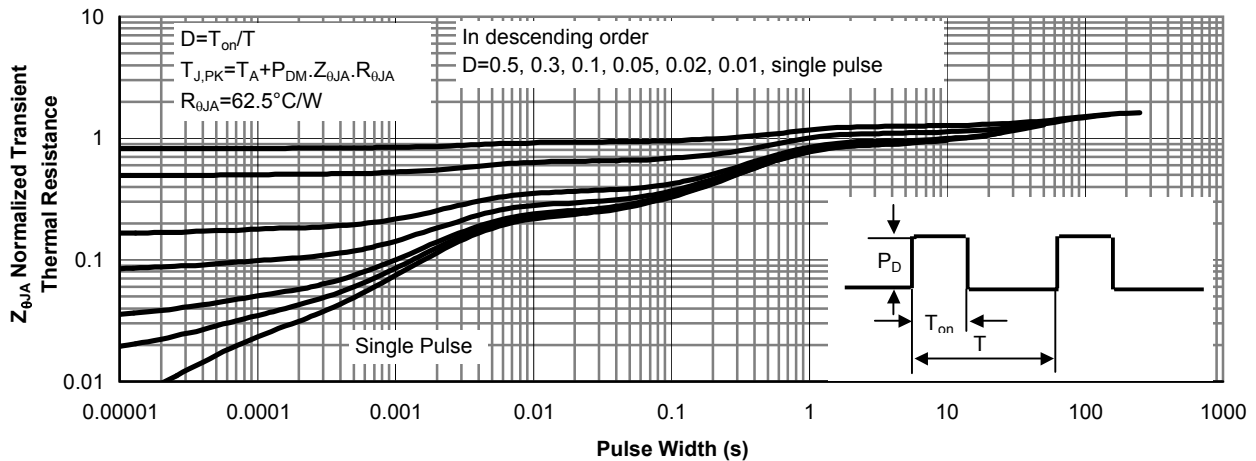


Figure 11: Normalized Maximum Transient Thermal Impedance

P-CHANNEL TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

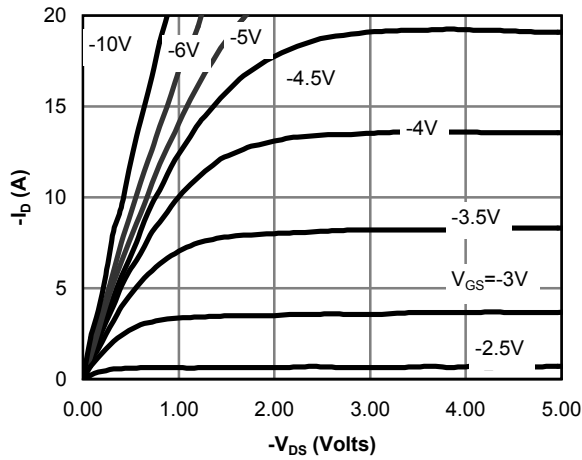


Figure 1: On-Region Characteristics

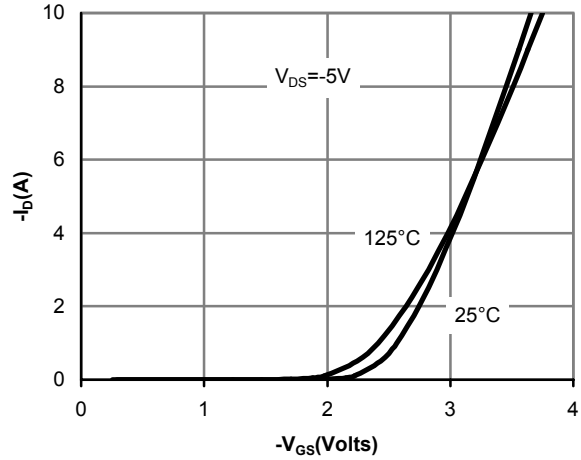


Figure 2: Transfer Characteristics

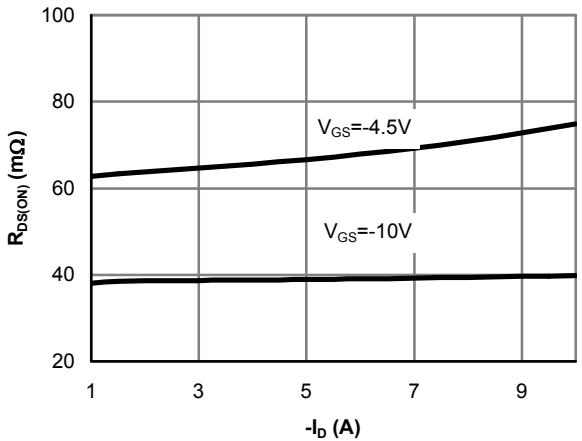


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

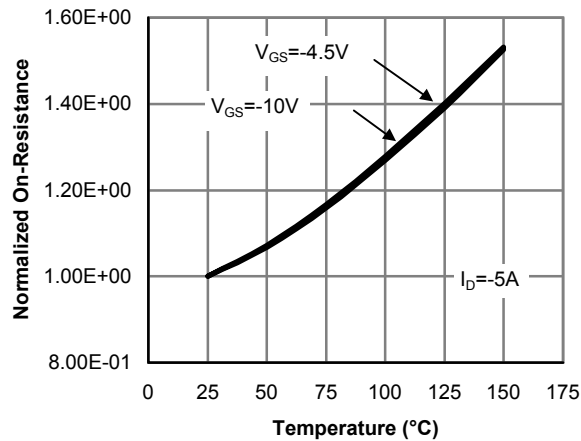


Figure 4: On-Resistance vs. Junction Temperature

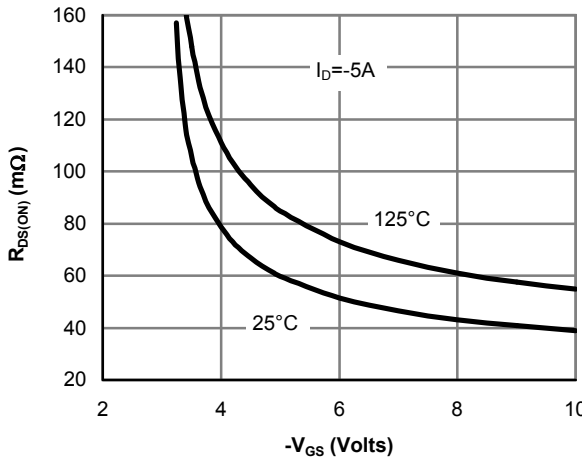


Figure 5: On-Resistance vs. Gate-Source Voltage

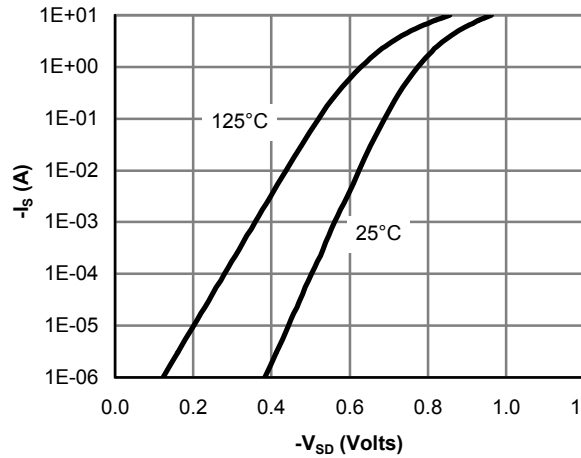


Figure 6: Body-Diode Characteristics

P-CHANNEL TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

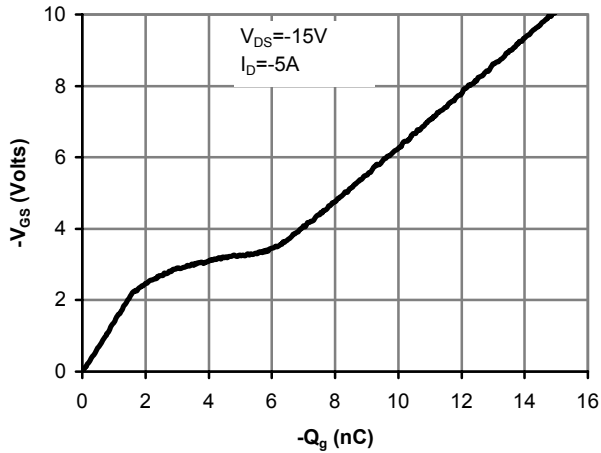


Figure 7: Gate-Charge Characteristics

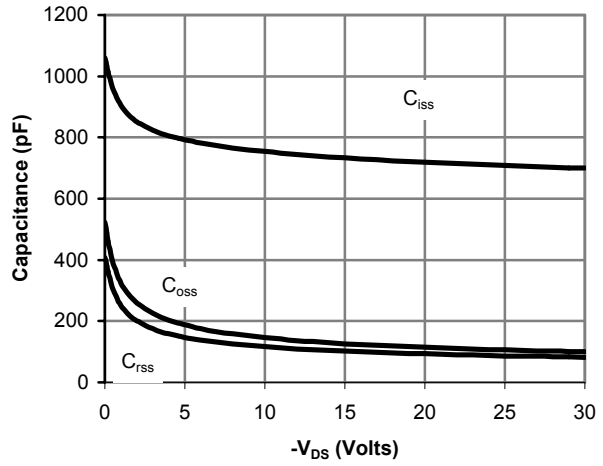


Figure 8: Capacitance Characteristics

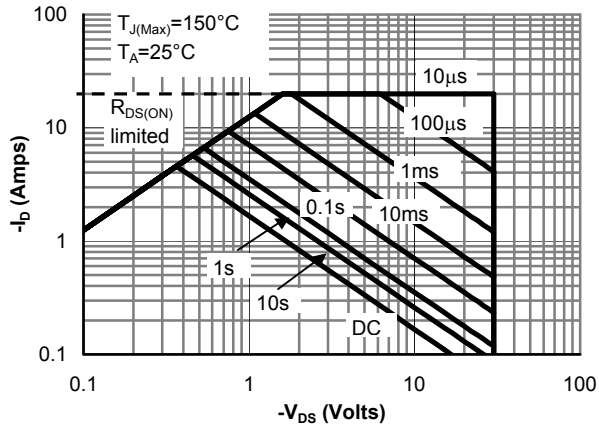


Figure 9: Maximum Forward Biased Safe Operating Area (Note E)

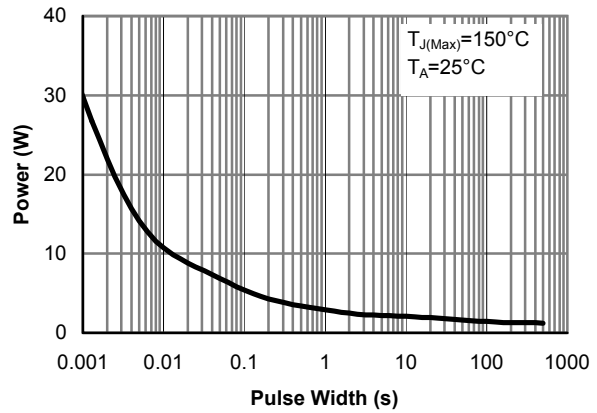


Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)

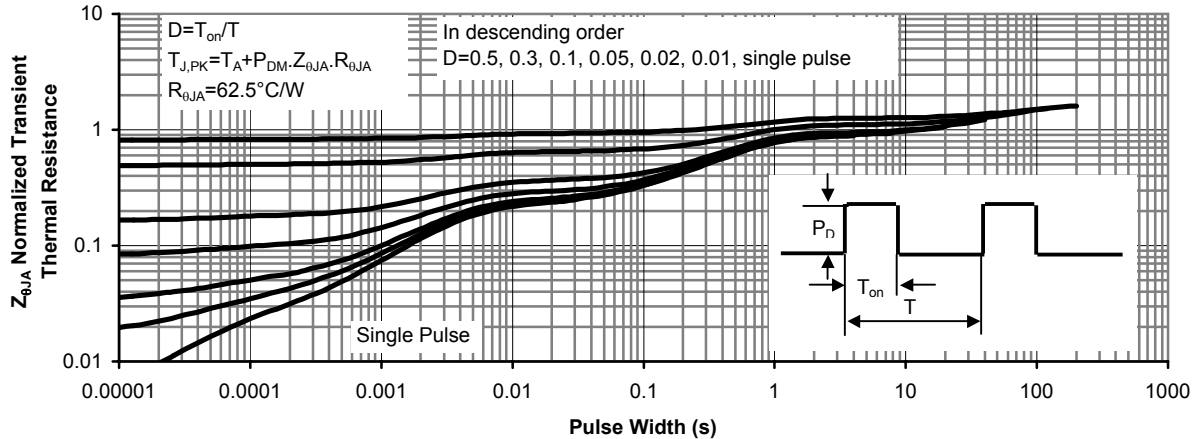
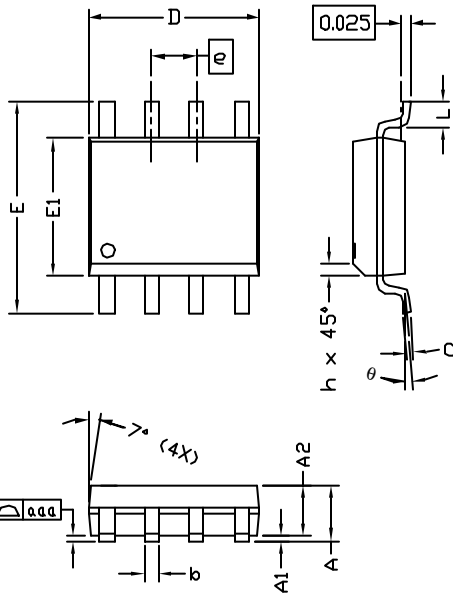


Figure 11: Normalized Maximum Transient Thermal Impedance



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° |

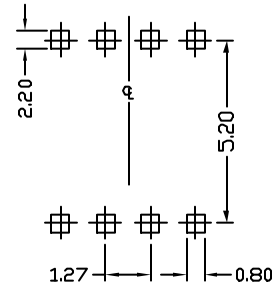
- NOTE:
- LEAD FINISH: 150 MICRONS (3.8 μm) MIN. THICKNESS OF Tin/Lead (SOLDER) PLATED ON LEAD
 - TOLERANCE ±0.10 mm (4 mil) UNLESS OTHERWISE SPECIFIED
 - COPLANARITY : 0.10 mm
 - DIMENSION L IS MEASURED IN GAGE PLANE

PACKAGE MARKING DESCRIPTION



- NOTE:
- LOGO - AOS LOGO
 - 4604 - PART NUMBER CODE.
 - F - FAB LOCATION
 - A - ASSEMBLY LOCATION
 - Y - YEAR CODE
 - W - WEEK CODE.
 - L C - ASSEMBLY LOT CODE

RECOMMENDED LAND PATTERN



UNIT: mm

SOP-8 PART NO. CODE

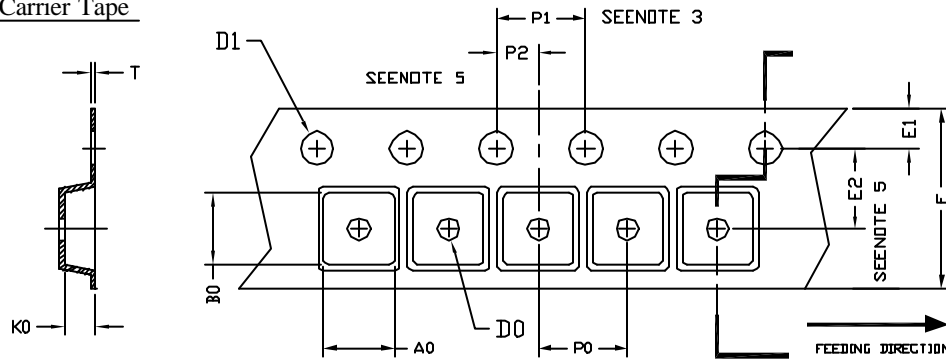
| PART NO. | CODE |
|----------|------|
| AO4604 | 4604 |
| | |



ALPHA & OMEGA
SEMICONDUCTOR, INC.

SO-8 Tape and Reel Data

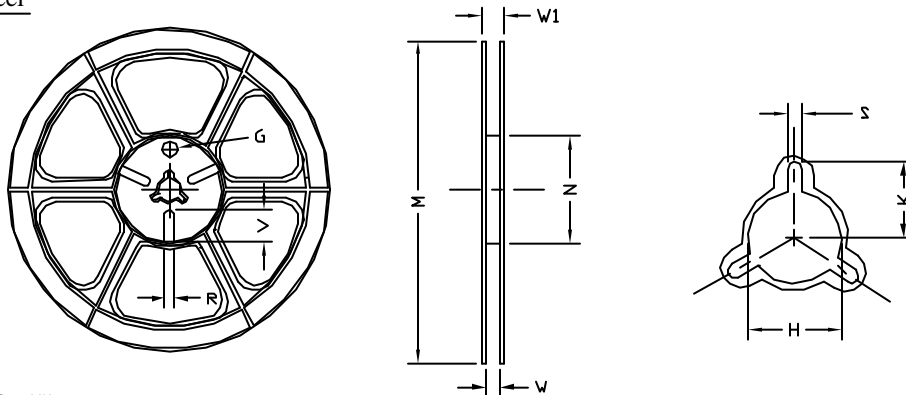
SO-8 Carrier Tape



UNIT: MM

| PACKAGE | A0 | B0 | K0 | D0 | D1 | E | E1 | E2 | P0 | P1 | P2 | T |
|-----------------|---------------|---------------|---------------|---------------|---------------|----------------|---------------|---------------|---------------|---------------|---------------|---------------|
| SO-8 (12 nm) | 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 | 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

