ALPHA & OMEGA SEMICONDUCTOR

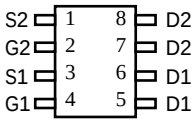
# AO4601
## Complementary Enhancement Mode Field Effect Transistor

### General Description

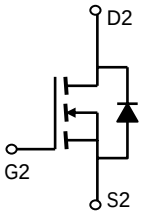
The AO4601 uses advanced trench technology MOSFETs to provide excellent $R_{DS(ON)}$ and low gate charge. The complementary MOSFETs may be used to form a level shifted high side switch, and for a host of other applications. *Standard Product AO4601 is Pb-free (meets ROHS & Sony 259 specifications). AO4601L is a Green Product ordering option. AO4601 and AO4601L are*

### Features

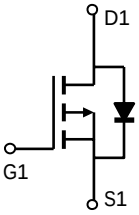
| n-channel | p-channel |
|---|---|
| $V_{DS}$ (V) = 30V | -30V |
| $I_D$ = 4.7A ($V_{GS}$=10V) | -8A ($V_{GS}$ = -20V) |
| $R_{DS(ON)}$ | $R_{DS(ON)}$ |
| < 55mΩ ($V_{GS}$=10V) | < 18mΩ ($V_{GS}$ = -20V) |
| < 70mΩ ($V_{GS}$=4.5V) | < 19mΩ ($V_{GS}$ = -10V) |
| < 110mΩ ($V_{GS}$ = 2.5V) | |




SOIC-8




n-channel




p-channel

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

| Parameter | | Symbol | Max n-channel | Max p-channel | Units |
|---|---|---|---|---|---|
| Drain-Source Voltage | | $V_{DS}$ | 30 | -30 | V |
| Gate-Source Voltage | | $V_{GS}$ | ±12 | ±25 | V |
| Continuous Drain Current [A] | $T_A$=25°C | $I_D$ | 4.7 | -8 | A |
| | $T_A$=70°C | | 4 | -6.9 | |
| Pulsed Drain Current [B] | | $I_{DM}$ | 30 | -50 | |
| Power Dissipation | $T_A$=25°C | $P_D$ | 2 | 2 | W |
| | $T_A$=70°C | | 1.44 | 1.44 | |
| Junction and Storage Temperature Range | | $T_J$, $T_{STG}$ | -55 to 150 | -55 to 150 | °C |

**Thermal Characteristics: n-channel and p-channel**

| Parameter | | Symbol | Device | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Maximum Junction-to-Ambient [A] | t ≤ 10s | $R_{\theta JA}$ | n-ch | 52 | 62.5 | °C/W |
| Maximum Junction-to-Ambient [A] | Steady-State | | n-ch | 78 | 110 | °C/W |
| Maximum Junction-to-Lead [C] | Steady-State | $R_{\theta JL}$ | n-ch | 48 | 60 | °C/W |
| Maximum Junction-to-Ambient [A] | t ≤ 10s | $R_{\theta JA}$ | p-ch | 50 | 62.5 | °C/W |
| Maximum Junction-to-Ambient [A] | Steady-State | | p-ch | 73 | 110 | °C/W |
| Maximum Junction-to-Lead [C] | Steady-State | $R_{\theta JL}$ | p-ch | 31 | 40 | °C/W |

## n-channel MOSFET 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 | 0.6 | 1 | 1.4 | V |
| $I_{D(ON)}$ | On state drain current | $V_{GS}$=4.5V, $V_{DS}$=5V | 10 | | | A |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}$=10V, $I_D$=4A | | 45 | 55 | mΩ |
| | | $T_J$=125°C | | 66 | 80 | |
| | | $V_{GS}$=4.5V, $I_D$=3A | | 55 | 70 | mΩ |
| | | $V_{GS}$=2.5V, $I_D$=2A | | 83 | 110 | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$=5V, $I_D$=4A | | 8 | | S |
| $V_{SD}$ | Diode Forward Voltage | $I_S$=1A,$V_{GS}$=0V | | 0.8 | 1 | V |
| $I_S$ | Maximum Body-Diode Continuous Current | | | | 2.5 | A |
| **DYNAMIC PARAMETERS** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{GS}$=0V, $V_{DS}$=15V, f=1MHz | | 390 | | pF |
| $C_{oss}$ | Output Capacitance | | | 54.5 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 41 | | pF |
| $R_g$ | Gate resistance | $V_{GS}$=0V, $V_{DS}$=0V, f=1MHz | | 3 | | Ω |
| **SWITCHING PARAMETERS** | | | | | | |
| $Q_g$ | Total Gate Charge | $V_{GS}$=4.5V, $V_{DS}$=15V, $I_D$=4A | | 0.6 | | nC |
| $Q_{gs}$ | Gate Source Charge | | | 1.38 | | nC |
| $Q_{gd}$ | Gate Drain Charge | | | 4.34 | | nC |
| $t_{D(on)}$ | Turn-On DelayTime | $V_{GS}$=10V, $V_{DS}$=15V, $R_L$=3.75Ω, $R_{GEN}$=6Ω | | 3.3 | | ns |
| $t_r$ | Turn-On Rise Time | | | 1 | | ns |
| $t_{D(off)}$ | Turn-Off DelayTime | | | 21.7 | | ns |
| $t_f$ | Turn-Off Fall Time | | | 2.1 | | ns |
| $t_{rr}$ | Body Diode Reverse Recovery Time | $I_F$=4A, dI/dt=100A/µs | | 12 | | ns |
| $Q_{rr}$ | Body Diode Reverse Recovery Charge | $I_F$=4A, dI/dt=100A/µs | | 6.3 | | 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 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 are obtained using 80 µs 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.

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## N-CHANNEL TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

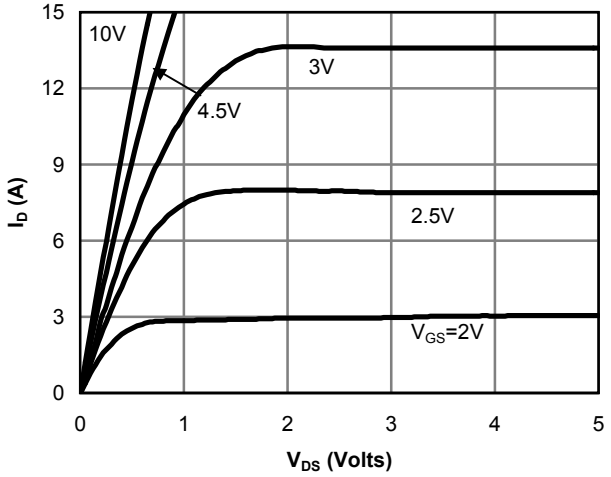



**Fig 1: On-Region Characteristics**

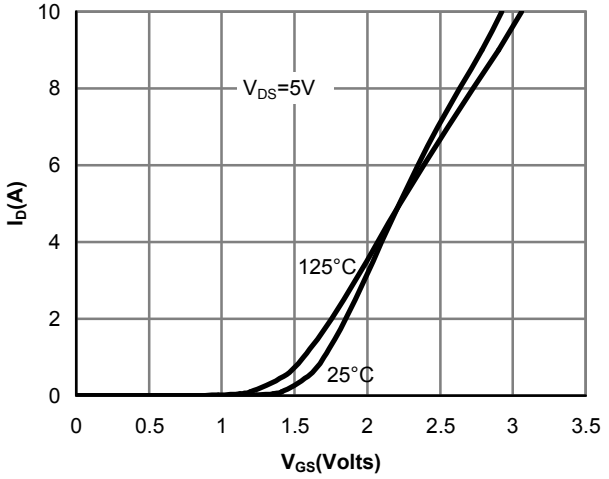



**Figure 2: Transfer Characteristics**

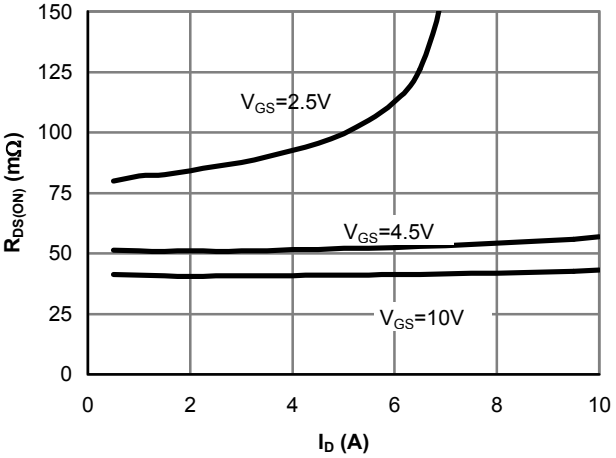



**Figure 3: On-Resistance vs. Drain Current and Gate Voltage**

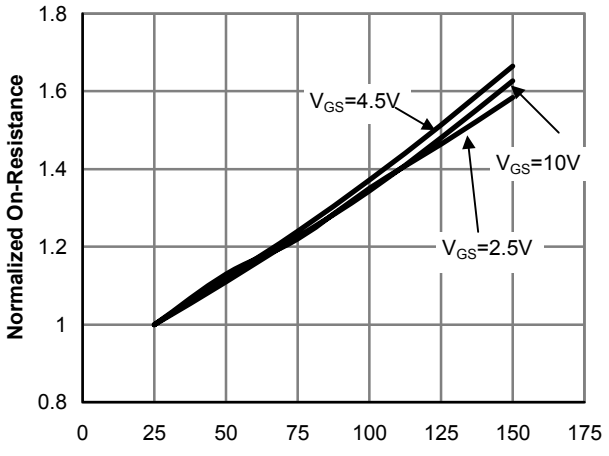



**Figure 4: On-Resistance vs. Junction Temperature**

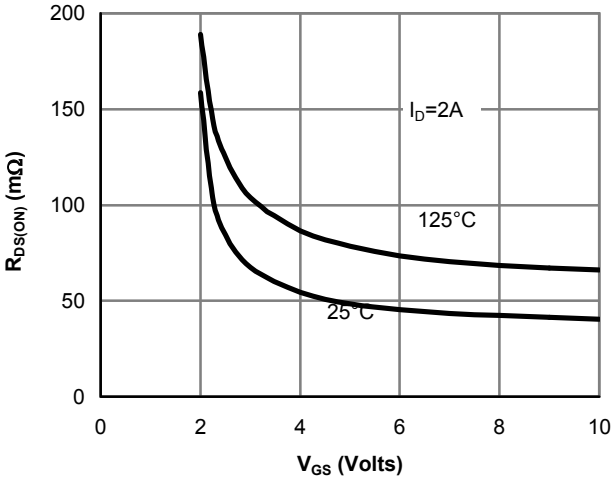



**Figure 5: On-Resistance vs. Gate-Source Voltage**

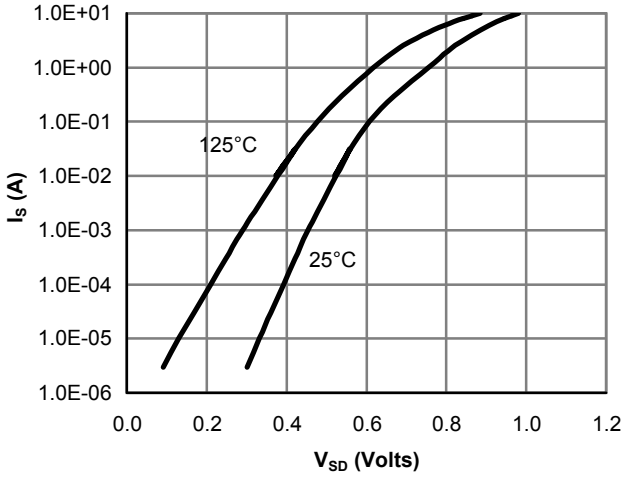



**Figure 6: Body-Diode Characteristics**

## N-CHANNEL TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

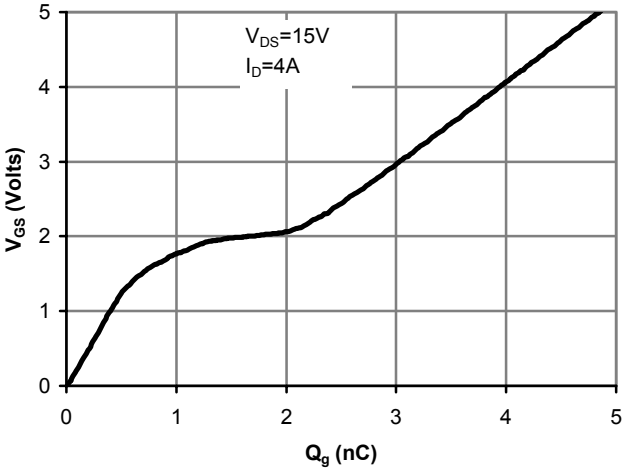



**Figure 7: Gate-Charge Characteristics**

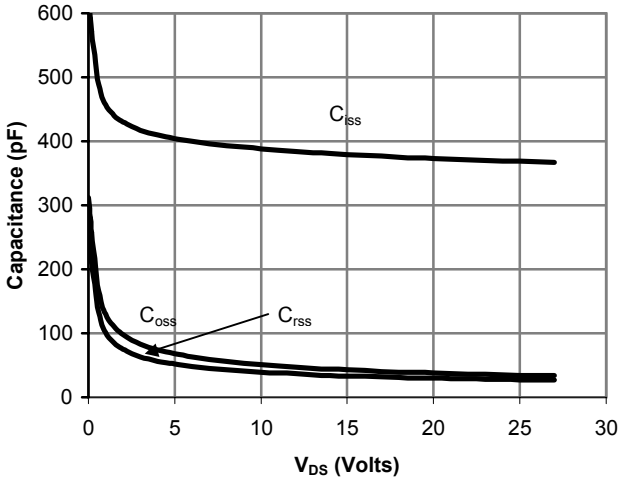



**Figure 8: Capacitance Characteristics**

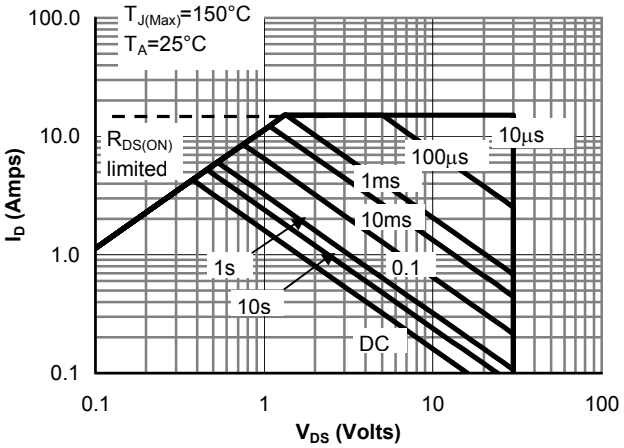



**Figure 9: Maximum Forward Biased Safe Operating Area (Note E)**

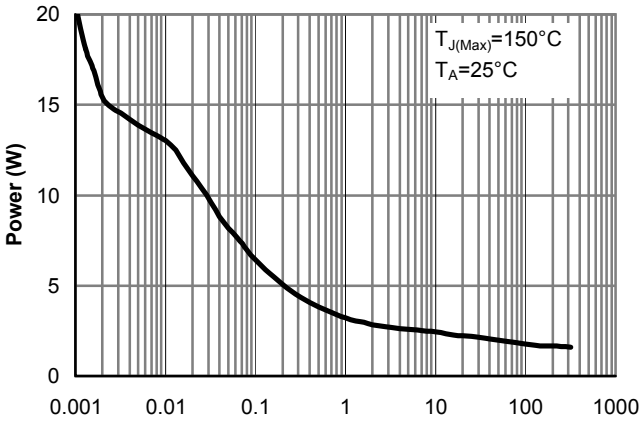



**Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)**

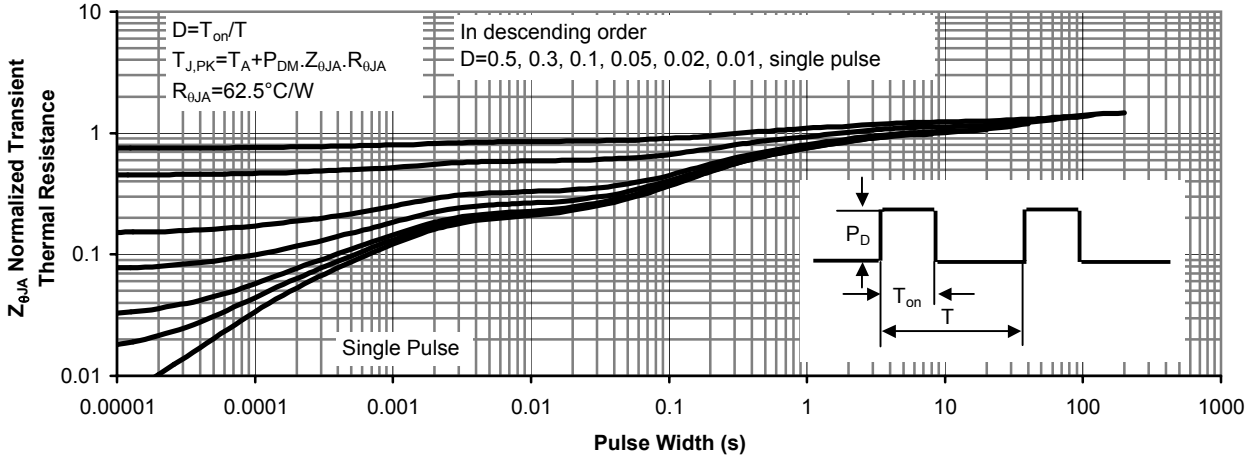



**Figure 11: Normalized Maximum Transient Thermal Impedance**

## p-channel MOSFET 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, $V_{GS}$=±25V | | | ±100 | nA |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$=$V_{GS}$ $I_D$=-250µA | -1.7 | -2.5 | -3 | V |
| $I_{D(ON)}$ | On state drain current | $V_{GS}$=-10V, $V_{DS}$=-5V | 40 | | | A |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}$=-10V, $I_D$=-8A | | 16 | 19 | mΩ |
| | | $T_J$=125°C | | 20.5 | 25 | |
| | | $V_{GS}$=-20V, $I_D$=-8A | | 15 | 18 | mΩ |
| | | $V_{GS}$=-4.5V, $I_D$=-5A | | 33 | | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$=-5V, $I_D$=-8A | 16 | 21 | | S |
| $V_{SD}$ | Diode Forward Voltage | $I_S$=-1A,$V_{GS}$=0V | | -0.75 | -1 | V |
| $I_S$ | Maximum Body-Diode Continuous Current | | | | -2.6 | A |
| **DYNAMIC PARAMETERS** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{GS}$=0V, $V_{DS}$=-15V, f=1MHz | | 2076 | | pF |
| $C_{oss}$ | Output Capacitance | | | 503 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 302 | | pF |
| $R_g$ | Gate resistance | $V_{GS}$=0V, $V_{DS}$=0V, f=1MHz | | 2 | | Ω |
| **SWITCHING PARAMETERS** | | | | | | |
| $Q_g$ | Total Gate Charge | $V_{GS}$=-10V, $V_{DS}$=-15V, $I_D$=-8A | | 39 | | nC |
| $Q_{gs}$ | Gate Source Charge | | | 8 | | nC |
| $Q_{gd}$ | Gate Drain Charge | | | 11.4 | | nC |
| $t_{D(on)}$ | Turn-On DelayTime | $V_{GS}$=-10V, $V_{DS}$=-15V, $R_L$=1.8Ω, $R_{GEN}$=3Ω | | 12.7 | | ns |
| $t_r$ | Turn-On Rise Time | | | 7 | | ns |
| $t_{D(off)}$ | Turn-Off DelayTime | | | 25.2 | | ns |
| $t_f$ | Turn-Off Fall Time | | | 12 | | ns |
| $t_{rr}$ | Body Diode Reverse Recovery Time | $I_F$=-8A, dI/dt=100A/µs | | 32 | | ns |
| $Q_{rr}$ | Body Diode Reverse Recovery Charge | $I_F$=-8A, dI/dt=100A/µs | | 26 | | 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 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 80 µs 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.

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## P-CHANNEL TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

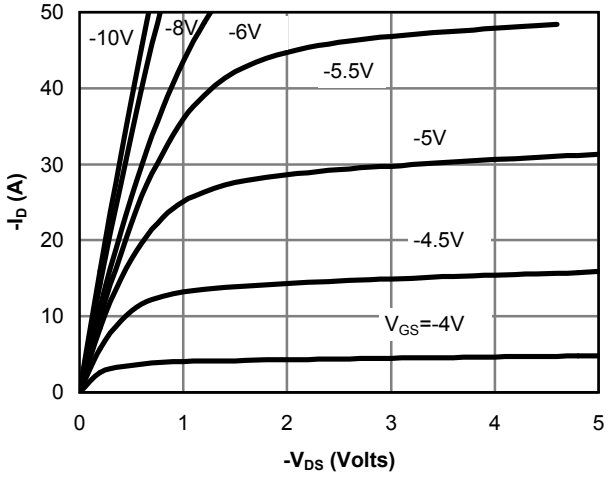



**Fig 1: On-Region Characteristics**

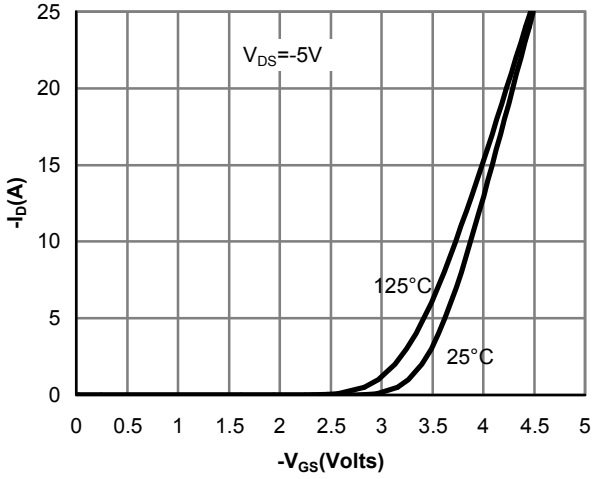



**Figure 2: Transfer Characteristics**

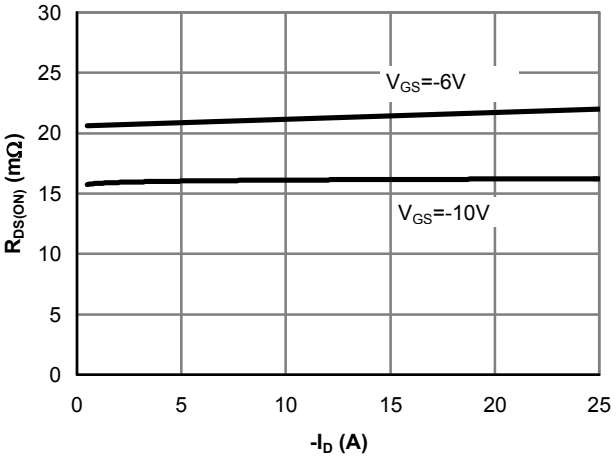



**Figure 3: On-Resistance vs. Drain Current and Gate Voltage**

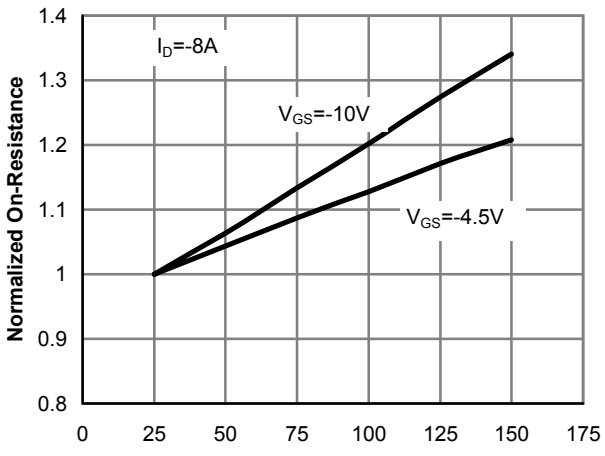



**Figure 4: On-Resistance vs. Junction Temperature**

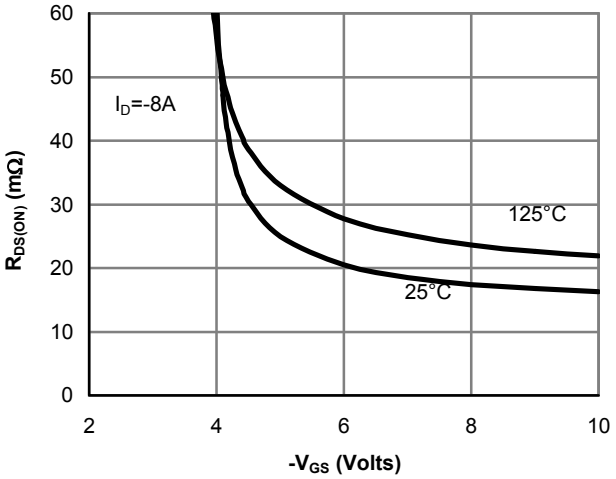



**Figure 5: On-Resistance vs. Gate-Source Voltage**

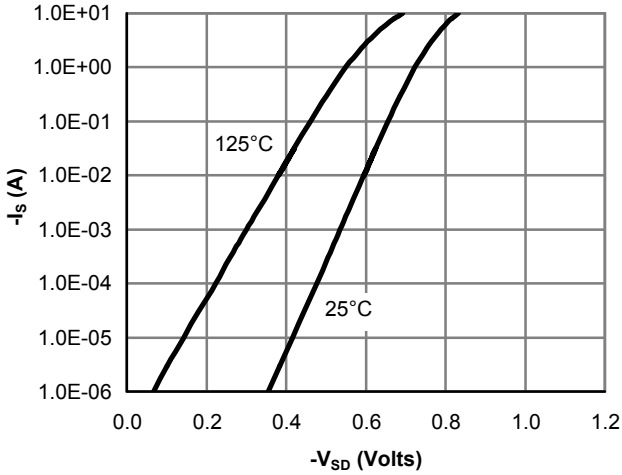



**Figure 6: Body-Diode Characteristics**

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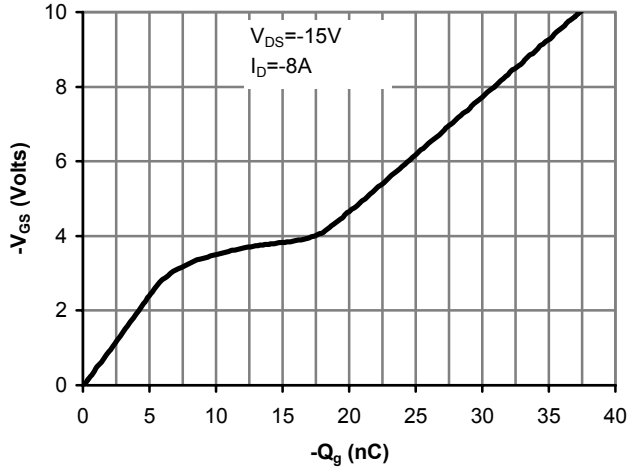



**Figure 7: Gate-Charge Characteristics**

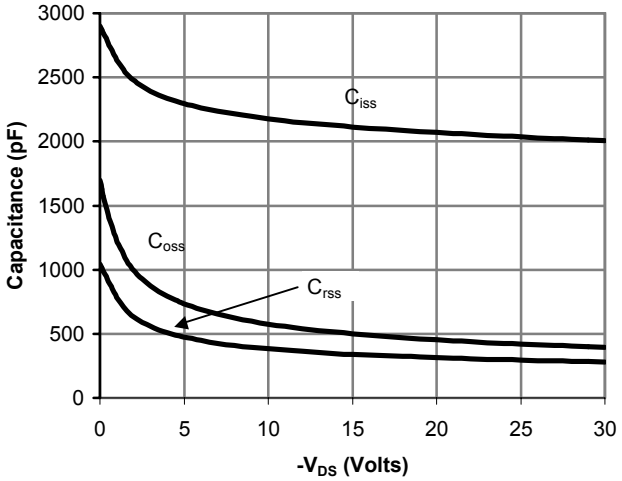



**Figure 8: Capacitance Characteristics**

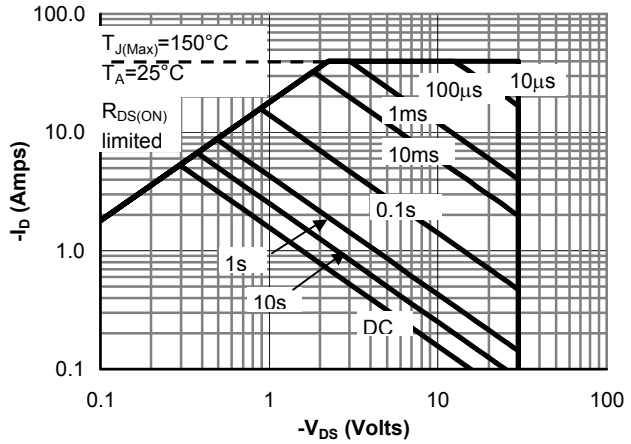



**Figure 9: Maximum Forward Biased Safe Operating Area (Note E)**

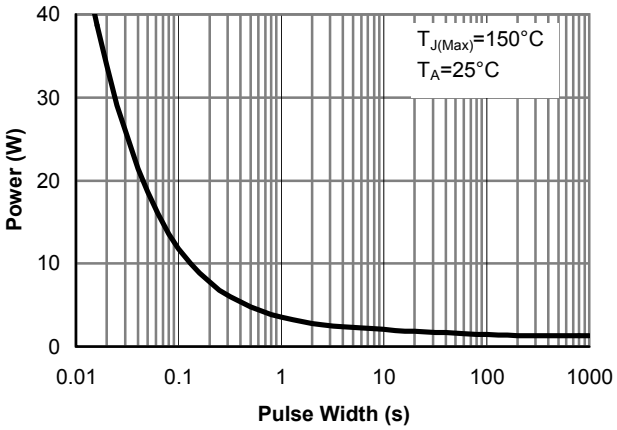



**Figure 10: Single Pulse Power Rating Junction-to-Ambient (Note E)**

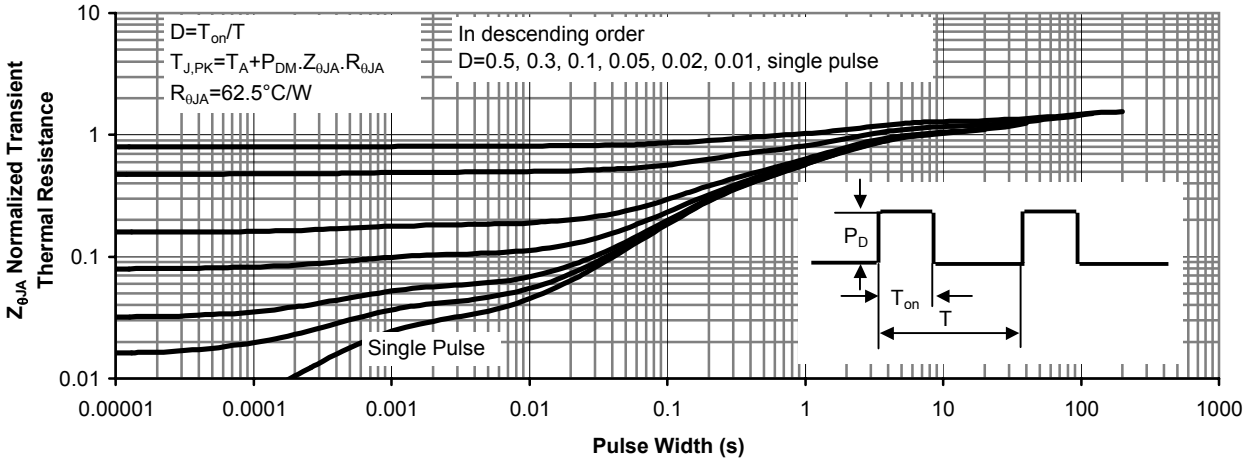



**Figure 11: Normalized Maximum Transient Thermal Impedance**